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GASOLINE AND DISTILLATE SHORTAGE SITUATION
1972-1976

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GASOLINE AND DISTILLATE SHORTAGE SITUATION: 1972-1976

Prepared For:		Environmental Protection Agency
By	:	ICF Incorporated
Under	:	BOA 68-01-0590, Order 002 (1458)

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Environmental Protection Agency
Washington, D. C.

Gentlemen:

We are pleased to submit our final report which details findings and conclusions in connection with our study of the short-to-moderate term gasoline and distillate supply situation. This report completes our study effort under your Basic Ordering Agreement Number 68-01-0590, Order Number 002 (1458).

We have found this assignment to have been challenging and interesting.

Sincerely,

ICF Incorporated

A partial history of [illegible]

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SECTION I:

DYNAMICS OF THE TIGHT GASOLINE AND DISTILLATE SUPPLY SITUATION

This section describes the gasoline and distillate demand and supply events which occurred during 1972 and the first quarter of 1973. Its purpose is to provide background for a demand and supply forecast, contained in the next section.

To accomplish this, it first summarizes the key features of the U. S. petroleum supply situation from 1966 through 1971. Next, it details the structural changes in the gasoline and distillate supply system which occurred during 1972 and the first quarter of 1973. Finally, it evaluates these events in the perspective of the government policies in effect over this period.

A. BACKGROUND

In 1966, evidence of a shift from an historical capability for domestic petroleum self-sufficiency to heavy reliance on imports began to solidify. By 1970, import dependency began to accelerate rapidly. The resulting large annual increases in imports -- and their makeup between crude and products -- created an unstable U. S. supply situation which helped to cause domestic gasoline and distillate shortages during 1972. These instabilities, and a recurring potential for further shortages, may persist through 1976. In addition, continually increasing reliance on petroleum imports, coupled with current import supply patterns, will increase U. S. vulnerability to an interruption in foreign petroleum supply.

1. KEY PETROLEUM SUPPLY AND DEMAND TRENDS: 1966-1971

Three major trends affecting U. S. petroleum supply appeared in 1966 and intensified dramatically during 1970. Specifically in 1970:

- Domestic crude production peaked, then began to decline;
- Domestic refinery construction began to slow down; and
- Crude and products stock positions began to deteriorate.

Declining domestic crude production in the face of increasing domestic demand magnified the overall need for petroleum imports. The simultaneous lag in domestic refinery capacity, coupled with a traditional domestic refining strategy oriented toward gasoline, focused the import requirement on a few refined products. These factors and the supply patterns underlying foreign imports created an unstable supply situation, which was evidenced first in deteriorating stock positions. And, conversely, worsening stock positions increased the potential for domestic shortages in light of the fundamentally unstable supply situation. These trends and their implications for the 1972-1973 period are detailed below:

a. Trends in Crude Production and Refining Capacity

Over the six-year period, 1966-1971, U.S. crude production growth first slowed, then peaked in 1970 and, finally, declined in 1971. Over the same period, the outlook for additions to domestic refinery capacity became unfavorable; firm commitments to add capacity dropped virtually to zero beyond 1972. Both trends, compared to demand growth, are shown on the following page:

Trends: Crude Production and Refinery Capacity

	Products Demand	Crude Production	Refinery Additions
1965*	100	100	100
1969	123	118	118
1970	128	123	123
1971	132	121	127
1972	142	121	128

Source: U.S. Bureau of Mines

* Index values are used to highlight the cumulative effects of different growth rates of demand and various components of supply. All of the base index values are set to 100. Although this technique highlights effectively the magnifying effect of a small percentage supply demand gap on initially small sources of supply such as imports, care should be taken to avoid comparing the absolute amounts of index values for any single year.

Beginning even prior to 1966, decreasing rates of domestic geophysical and geological activity and of exploratory drilling signaled an eventual decline in domestic crude production. In response, U.S. proved reserves declined by approximately 10 percent from 1966 through 1970 -- excluding the major increase in reserves provided by North Slope discoveries, which have not yet been produced to any extent. As a final measure of tightening domestic crude production capacity, market-demand factors (the percent of schedule allowable or regulated MER that non-exempt wells are allowed to produce in the market-demand prorationing states, which account for the major portion of domestic crude production) began to rise markedly after 1965; these factors approached 100 percent by the end of 1971.

b. Trends in Imports and Domestic Stock Positions: 1966-1971

As indicated in the preceding table, petroleum products demand consistently grew faster than domestic crude production from 1966 through 1971. Concurrently, refinery additions grew slightly faster than domestic crude production, but also more slowly than demand.

To make up the domestic crude shortfall, either crude imports could be expected to increase or crude stocks could be expected to decline. As indicated below, both occurred:

Trends: Crude Stocks and Crude Imports

		Crude Sources		
	Refinery Runs	U.S. Production	Crude Stocks	Crude Imports
1965	100	100	100	100
1969	118	118	120	124
1970	120	123	125	116
1971	124	121	118	148
1972	129	121	112	195

Source: U.S. Bureau of Mines

In turn, to make up the growing shortfall between the outputs of domestic refineries and petroleum products demand, either product imports could be expected to increase or products stocks could be expected to decline. Again, both occurred, as indicated on the following page:

Trends: Product Imports and Stocks

		Products Sources		
	Demand	U.S. Refinery Outputs	Products Stocks	Products Imports
1965	100	100	100	100
1969	123	118	112	146
1970	128	120	115	174
1971	132	124	118	181
1972	142	129	111	201

Source: U. S. Bureau of Mines

This widening gap between domestic demand and domestic supply of crude and refinery outputs produced large percentage increases in crude and products import requirements.

Taken together, these trends in the domestic supply situation can be summarized as follows:

- During the 1966-1971 period, as domestic crude production declined, refinery expansion slowed. As the rate of increase in crude imports accelerated, crude stocks declined.
- Despite a mild slackening of demand growth during 1970 and 1971, the gap between domestic demand and domestic refining increased; in turn products imports increased. As the rate of products imports accelerated, products stocks declined.
- At the beginning of 1972 -- a point where demand began a period of growth at a higher than normal rate -- U. S. crude production was declining, imports were accelerated rapidly, and stocks were lower than normal.

c. Trends in the Domestic Refining Strategy: 1966-1971

As indicated above, products imports increased over the 1966-1971 period to fill the gap between domestic demand and domestic production of refined products.

Three products of special interest, however, exhibited different demand growth rates, as shown below:

Trends: Demand Growth of Key Petroleum Products

	All Products	Gasoline	Distillate	Residual
1965	100	100	100	100
1969	123	120	116	123
1970	128	126	119	137
1971	132	131	120	138
1972	142	139	132	152

Source: U. S. Bureau of Mines

Up to a point, dictated by technical limits on refinery yields of each product, domestic refineries could have been adjusted either to distribute the import requirement proportionately across all products or to force the requirement into a narrow group of products. Domestic refining strategy followed the latter course, for four reasons:

- Generally, domestic self-sufficiency was maintained for gasoline. This was consistent with motor gasoline's lack of fuels competition, which permitted gasoline prices and profit margins adequate to support domestic crude prices at high levels compared to world crude prices.

- In contrast, domestic residual production was minimized. This was consistent with the domestic competition between residual and coal, which dictated residual prices and profit margins compatible only with low-priced world crude and which allowed residual to penetrate domestic regions without local coal supplies, with access to waterborne residual shipments, and with air quality problems affecting coal's competitiveness.

- Distillate, because it lacked competition in certain segments of the country (e.g., New England) due to lower availability of natural gas for residential use, was both produced domestically and imported at moderate levels;

- Finally, Federal import policies directly and indirectly reinforced this domestic refining strategy:
  - -- By protecting expensive domestic crude from the competition of cheaper foreign crude through a volumetric quota program, import policy encouraged domestic production of less price constrained products (especially gasoline).
  - -- By exempting residual imports (to PAD I), import policy allowed residual refined offshore from cheaper foreign crude to compete with coal.
  - -- By providing selected import exemptions (distillate for ship bunkers and bonded jet fuel and kerosine), it encouraged part of the product import requirement to fall on these fuels.

Together, the varying growth rates for different products and the special competitive accommodations afforded petroleum through import policy caused a secular shift of domestic refining yields and of the mix of products imports. Principally, gasoline yields increased at the expense of kerosine and jet fuel, as shown below:

Changes in Domestic Refining Yields
(% of Total Yield on Crude)

	Gasoline	Kerosine & Jet Fuel	Distillate	Residual
1966-1969	+0.3	+0.9	+0.9	+0.7
1969-1972	+1.4	-1.8	+0.6	-0.1

Source: U.S. Bureau of Mines

By the end of the period (1970-1971), products imports consisted mainly of residual, followed by kerosine and jet fuel, then, distillates. In addition, imports accounted for a large share of domestic demand, particularly for residual but also for middle distillates:

Make-Up of Products Imports: 1971-1972

	Percent of Demand Imported	Percent of All Products Imports
Residual	70	81
Kerosine/Jet Fuel	15	10
Distillate	7	8

Source: U.S. Bureau of Mines

d. Trends in Sources of U.S. Imports: 1966-1971

In 1966, U.S. crude and products imports originated mainly within the Western Hemisphere. By the end of 1971, however, import origins for crude extended substantially to the Eastern Hemisphere, principally to the Middle East and North Africa. In contrast, products imports continued to concentrate in the Western Hemisphere (primarily from the Caribbean), but crudes to support a large portion of these products imports also originated in the Middle East and North Africa. More importantly, the U.S. take from its import sources represented either the overwhelming share or only a minor share of these sources' exports, as indicated below:

Share of Exports Shipped to the U.S.

	Crude	Products
Canada	98	100
Caribbean	11*	68
North Africa	2	-
Mid-East	6	-
Far-East	10	6

---

* Indirectly, the majority of Caribbean crude exports entered the U.S. ultimately in the form of as Caribbean-refined products.

As shown above, areas providing U. S. imports were either entirely U. S. - dedicated or almost entirely independent of the U. S. market. In the former case, refinery capacity in the Caribbean was built at a rate just adequate to meet U. S. products import growth; as a result, Caribbean refineries generally operated at high utilization rates and expanded only adequately to maintain these high rates. In addition, because residual made up the bulk of U. S. products imports, Caribbean refineries were simple in design and lacked downstream converting capacity for making lighter products. Consequently, their flexibility to alter their product slates in response to short run demand variations was limited.

In summary, by the end of 1966-1972 period a long-standing domestic refining and import strategy had led to U. S. dedicated crude production and product refining in a few areas immediately offshore. This dedicated capacity, however, was capable of only minimal changes in product slate or increases in total output in the short run. Elsewhere, the U. S. was a relatively minor factor; the U. S. market represented on outlet of secondary importance. Consequently, these areas served the needs of others first and supplied the U. S. only as spare capacity permitted.

2. IMPLICATIONS FOR CRUDE AND PRODUCTS SUPPLIES DURING 1972

The basic trends outlined above take on greatest significance when viewed retrospectively from 1972. On the supply side, 1972 represented a continuation of trends which developed gradually since 1966. From the standpoint, however, of encountering an abrupt demand gain -- whether forecast in advance or not -- the supply structure that evolved from 1966 through 1971 had a series of interrelated weaknesses:

- Even with normal demand growth, increased crude imports would be required to offset domestic crude production declines. With above-normal demand growth, crude imports would need to expand significantly. Although import growth would look small as a percent of total domestic refinery inputs, it would look large from the viewpoint of potential supplying countries. Moreover, since domestic refineries tended to be locked into sweeter domestic crudes, the quality of crude suitable for import and, in turn, the potential import sources would be constrained.

- With an abrupt growth in demand, a large share of the growth would be forced onto products, principally because spare domestic refinery capacity was limited, both in total and by any constraints encountered in obtaining sweet crudes.

- Products import growth would fall heavily onto fuels rather than gasoline, thereby compounding the import growth problem. First, domestic refining capacity and economics favored gasoline. Secondly, both dedicated offshore refining capacity and spare capacity in other areas were fuels-oriented; in addition, gasoline produced in these areas was of lower quality by U. S. standards, which would limit the amounts of imports which could be introduced into the domestic gasoline pool.

- The majority of crude and products imports to meet an abrupt demand increase would need to originate outside of the principal, traditional U. S. source-countries. Generally, Western Hemisphere crude production and refining areas were operating nearly flat-out. Unfortunately, these non-dedicated areas were principally oriented to other consuming countries whose rapidly growing demands could be expected to take priority.

- Finally, the U. S. would be ill-prepared domestically to take up any supply slack encounted in reaching out to new areas for imports. As indicated previously, little spare capacity to produce or refine crude existed domestically. More fundamentally, any "safety" built into crude or products stocks had eroded during the previous period of expanding imports.

In addition, the environment for supply expansion generally was not favorable. First, volumetric quotas on imports still existed; also, a set of firm price controls were in place.

B. DEMAND-SUPPLY RESPONSE: 1972 THROUGH MARCH, 1973

In our introduction, we pointed out that an accelerating gap between domestic demand and domestic supply would have three broad effects in the U. S. petroleum supply system:

- Import volumes would grow quickly;
- These import volumes would place large, incremental U. S. -related demands on foreign supply sources; and
- A simultaneous restructuring of domestic supply logistics would be required to accomodate imports.

The preceding portion of this section described the key trends in U. S. petroleum demand and supply from 1966 through 1971 and summarized their implications in case demand growth accelerated. During 1972, and through the first quarter of 1973, a higher than normal demand growth rate was experienced, accompanied by back-to-back shorages of distillate and gasoline. Here, we describe the magnitude and incidence of the supply and demand events which occurred throughout 1972 and early 1973. First, a brief overview of the shortage incidents and where they impacted is presented. Then, the supply response is presented in detail at various levels throughout the supply system.

1. OVERVIEW

Two shortages occurred since the beginning of 1972. The first involved distillate and took place during the first half of the 1972-73 heating season. In the aggregate, the impact of the shortage was mild, but spot shortages caused severe problems for a limited number of people for short periods. Although the shortage was evidenced as distillate, it stemmed, on the demand side, principally from inadequate supplies of competing fuels -- especially natural gas -- overlayed on abnormally cold weather during the first half of the 1972-73 heating season.

The second shortage involved gasoline; it was less mild and occurred during the second quarter of 1973. In this case, curtailment of supplies of substitute fuels was not involved directly. Instead, the extended manufacture of an alternative refinery product -- principally distillate -- overlayed unusually high gasoline consumption during the first quarter of 1973 to worsen an otherwise tight supply situation. The adjustment to the gasoline shortage was felt more broadly. The shortage approached a rationing situation and "grey" market instances occurred. In response, gasoline consumption moderated, apparently due to the threat of a general shortage. This gasoline-use decline, however, caused no discernibly serious curtailment of economic activity or alterations in lifestyles.

In both cases, however, there were serious consequences of the shortages, which fell on a few activities. These were of three kinds:

- Independent gasoline refiners and marketers had their supplies dried up and their historical price advantage over the "majors" nearly eliminated. As a result, their market share reversed its upward trend, and the less financially strong operations ceased doing business.

- All gasoline retailers lost "opportunity" revenues; in turn, they eliminated a service component of their good (24-hour, seven-day a week operations). Those with high fixed costs or financially marginal status either actually lost money or closed permanently.

- Consumers located in more-remote areas or who typically represented a bargin-priced dumping ground for previous surpluses of refined products had supplies tightened and prices raised. These groups included areas distant from refining centers and major logistical systems (e.g., Northern Maine, Denver) and numerous bulk buyers (e.g., governments, institutions and transportation companies).

2. ANALYTICAL APPROACH

This section of our report focuses mainly on the supply events which occurred during the shortage incidents of 1972 and early 1973. In the case of both gasoline and distillate, the supply shortfall was small volume-wise and percentage-wise. For this reason, our analysis attempts to identify what occurred on the margin. This is done by computing the absolute and percentage changes in oil flows which occurred between 1971 and 1972. Each year is disaggregated by quarter and by Petroleum Administration for Defense district (PAD). Also, crude production, refining, and transportation are addressed individually.

Because of the small nature of the shortages involved, use of this approach raises two issues. First, the changes it reveals may represent only "noise" in the data collection and reporting system. This problem undoubtedly exists; but we believe it affects the degree of change our approach reveals insufficiently to invalidate our conclusions. Secondly, a similar year-to-year comparison -- say, for 1971 versus 1970 -- might show that levels of change exhibited in 1972 are normal. A check of prior years indicates that this is not the case.

3. CHANGES IN DEMAND

During 1972 and the first quarter of 1973, growth in domestic demand for petroleum products played a critical role in causing shortages. To meet higher demands, two approaches for increasing supply theoretically were available. The most obvious would involve lifting and refining more crude, both domestically and in foreign crude producing and crude refining areas.

The second would involve drawing down crude and products stocks. Normally, stocks act as a buffer between "final"petroleum demand and the "new supply" created by lifting and refining crude. Stock levels are set to minimize logistical and production problems associated with attempting to meet current demand from current production. Also, a portion of stock levels exists to provide a "safety margin" for unforecast demand and supply events.

If stocks are flush, they can be drawn down to buffer the impact of unforeseen demands on the supply system. If, however, stocks are thin, extra pressure is exerted on the supply system. Not only must a larger new supply be created by lifting and refining but also the supply system must track demand on a more nearly current basis until stocks can be rebuilt, which allows fewer mistakes to be made while simultaneously expanding supply capability. Because stocks play this middle role -- determining the level of net demand versus gross demand or, alternatively, determining the net supply and gross supply requirement in any period -- our analysis treats stocks from the perspective of both demand changes and the ensuing supply response.

a. Demand Growth in 1972-1973

After two successive years of slackened growth, petroleum consumption grew more rapidly than normal in 1972. Three products of special interest -- motor gasoline, distillate and residual -- grew at higher than normal rates.

Annual Demand Growth

Period	All Products	Motor Gasoline	Distillate	Residual
1966-69	5.3%	4.8%	3.8%	5.4
1970-71	3.8	4.4	3.9	7.8
1972	7.8	6.0	9.5	13.3

Source: U.S. Bureau of Mines

For 1972, the details of the accelerated demand growth are shown in Table 1, at the end of Section 1 (all "numbered" tables appear at the end of this section). The key features of demand growth during 1972 are summarized below:

1972 Demand Growth
(Percent)

	1972			1973
PAD I-IV[*/]	Year	3Q	4Q	1Q
Gasoline	5.7	6.7	5.3	8.6
Distillate	10.2	7.5	18.0	1.9
Residual	14.0	16.8	29.1	10.1

[*/] PAD V is excluded, because the high demand growth occurred mainly in PADs I-IV.

Two key observations emerge from this table.

- Beginning with the third quarter of 1972 -- the outset of the winter heating season -- the time-pattern of the demand growth could be expected to create supply problems for three reasons:
  - -- Third quarter gasoline demand was unusually high; traditionally, lower third quarter gasoline demand permitted refinery yields to shift away from gasoline production in order to boost distillate stocks in anticipation of the heating season;
  - -- The majority of the heating fuels demand growth occurred during the fourth quarter; normally, the first quarter (or latter half of the heating season) accounts for the larger share of winter demand;
  - -- First quarter gasoline demand was unusually high; traditionally, lower first quarter demand was accompanied by a refinery yield shift back to gasoline production in order to boost gasoline stocks in anticipation of the summer driving season.
- Translated into barrels of consumption, gasoline and distillate demand grew in nearly equal volume amounts. Since gasoline output of domestic refineries normally equals twice the volume of distillate outputs, equal-volume demand increases for both products could be expected to lead to significantly increased distillate imports.

b. Accuracy of Demand Forecasting

In addition to the demand abnormalities which occurred in 1972 and early 1973, the gasoline and distillate shortages that occurred might have been caused by poor forecasting. The table, on the following page, compares actual and forecast demand, beginning with the third quarter of 1973.

Demand Forecasting Errors
(Ratio: Actual÷Forecast)

	1972			1973
PADs I-IV	3Q	4Q	Year	1Q
Gasoline	101.9	102.7	102.0	103.3
Distillate	101.7	109.8	103.4	94.0
Residual	112.6	112.1	106.7	94.4
Total Products	103.1	107.1	103.2	98.8
Adjusted*				
Distillate	-	(102.5)	(101.3)	(99.5)
Residual	-	(99.1)	(103.4)	(104.0)
Total Products	-	(103.7)	(10 .3)	(101.8)

---

* Adjusted ratio indicates forecasting accuracy which would have been achieved if the winter season had been normally distributed between the fourth and first quarters.

Computed from Bureau of Mines and Oil and Gas Journal data.

Compared to forecasting accuracies of the 1966-1971 period, the forecasting errors calculated above are not unusual. On a quarter-to-quarter basis, however, the forecasting errors do confirm the abnormal pattern of demand growth:

- Gasoline demand -- which accounted for the bulk of the error in forecasting total products demand -- consistently exceeded the forecast, and by ever-increasing amounts;

- Actual distillate demand, compared to forecast, reflected the the unusual pattern of winter weather; over the entire heating season, however, the forecasting error netted nearly to zero;

- Similar to distillate, residual demand reflected the abnormal weather pattern; unlike distillate, however, demand consistently exceeded the forecast.

c. Adequacy of Stocks to Offset Unforecast Demand

To the extent that the demand forecasting error exhibited during the second half of 1972 and the first quarter of 1973 was not unusual, the shortages which occurred might have stemmed from two other factors:

- The overall pattern of heating season demand was abnormal to a degree that normal refining and stock practices would have been severely tested, or
- Backup stocks were abnormally low.

The table, below, compares forecasting accuracies for the 1972-73 winter with those of prior years and shows opening stocks and the distribution of heating season demand between the fourth and first quarters over the entire five year period.

Distillate Demand and Stocks: Winters of 1968-1973

Heating Season	Demand (MB/D) Forecast	Demand (MB/D) Actual	Percent of Forecast Season's Demand 4th Quarter Demand	Percent of Forecast Season's Demand Opening Stocks
1968-69	492.8	504.4	45.1%	39.3%
1969-70	506.7	531.1	46.2	36.3
1970-71	543.7	543.0	43.3	35.5
1971=72	580.7	561.4	42.4	34.0
1972-73	606.4	611.8	48.0	29.2

Source: Bureau of Mines

As indicated above, the 1972-73 demand and stock situation was unusual in three ways:

- Total seasonal demand grew rapidly but was forecast with better than average accuracy.

- The fourth quarter accounted for at least a 2 percent larger share of total seasonal demand than anytime during the prior four-year period.
- Although September stock levels had been declining year-to-year, 1972 stocks were below trend by at least 4 percent.

If the pattern of the 1972-73 heating season had been similar to the 1971 (the most ideal of the years shown with respect to low fourth quarter demand), resulting in a stock drawdown smaller than for 1970 (the most ideal in terms of fourth quarter stock drawdowns), beginning stocks at the outset of the first quarter of 1973 still would have been lower than normal, as shown below:

1972: Impact on Stocks of an Ideal Fourth Quarter

Season	Stock Drawdown	Ending Stocks (% 1st Qtr. Demand)
1968-69	31.6 MMB	59.3%
1969-70	26.5	53.5
1970-71	10.5	59.4
1971-72	19.1	55.2
1972-73 Actual	36.2	41.3
Most Favorable	(2.6)	(51.1)

Consequently, distillate stock levels at the beginning of the heating season probably were the fundamental factor which led to season's mild distillate shortage; peculiar weather -- a cold fourth quarter and mild first quarter -- only compounded on already potentially marginal supply situation.

4. SUPPLY EVENTS DURING 1972

Three previous background observations provide the framework for analyzing supply events of 1972-1973:

- The trend away from near self-sufficiency with respect to petroleum and to greater import dependency already was:
  - -- Magnifying the growth rate of imports;
  - -- Placing large incremental U.S. demands on traditional and new sources of foreign supply; and
  - -- Causing an internal restructuring of domestic supply logistics to accomodate import growth.
- Demand during 1972 grew at a higher than normal rate in total, and quarter-to-quarter demand patterns created supply complications:
  - -- Gasoline and distillate grew in approximately equal volumes, in contrast to the traditional 2:1 ratio of gasoline and distillate outputs from domestic refineries; and
  - -- Gasoline, distillate and residual demand growth was unusual in three successive quarters, beginning with the third quarter of 1972.
- Stocks of crude and products were lower than normal, thereby potentially complicating the basic problems occasioned by accelerating imports and unusual demand growth:
  - -- Ideally, the new supply created during the year needed to exceed comsumption in order to recoup stock levels; and
  - -- Generally, new supply was tracking demand more closely than normal.

a. Overview of the Supply Problem

The table on the following page,summarizes the actual and planned changes in the supply situation for 1972:

1972: Actual and Forecast Demand and Supply Growth*

PADs I-IV	MB/D Increase		Percent Increase		Percent Difference
	Actual	Forecast	Actual	Forecast	
Total Demand	1050	600	8.0	4.6	+ 3.4
New Crude					
Domestic	-50	200	-0.6	2.4	- 3.0
Imports	380	170	32.7	14.5	+18.2
	330	370	3.5	3.9	- 0.4
Crude Runs	400	180	4.2	1.9	+ 2.3
Product Imports	170	180	8.4	8.9	- 0.5
Stock Change					
Crude	-39	0	-5.5	0	- 5.5
Products	-180	109	-9.7	5.7	15.4

Source: U.S. Bureau of Mines and Oil and Gas Journal.

* Excludes NGL's and processing gain.

As indicated above, the supply response to higher than forecast demand growth had three main features:

- Decreased domestic crude production, contrary to plan, forced increased imports; overall, however, total availability of new crude fell slightly short of forecast.
- Refinery runs increased above forecast, but at the expense of crude stocks and at a rate slightly more than half of the demand growth rate.
- Imports of products and unfinished oils, although increased, fell short of plan and did not close the domestic supply gap; as a result, product stocks declined.

b. Structural Changes in Crude Supply Logistics

During 1972, three major changes occurred in the domestic crude supply structure:

- Declining domestic crude production caused the logistic structure to draw inward toward domestic crude producing regions in order to protect local refining in these areas and to accomodate increased imports in areas with access to waterborne shipments.

- The growth in U. S. imports required to offset decreased domestic crude production and the somewhat collapsed domestic crude logistical structure caused a disproportionate share of overall free world crude production increases to be diverted to the U. S.; more importantly, U. S. imports of disproportionate size occurred with respect to sweet crude. Sweet crude imports not only absorbed all of the free world production increase but also cut into production shipped elsewhere in prior years.

- The international base of U. S. crude sources shifted substantially out of the Western Hemisphere.

Table 2, at the back of this section, shows the detailed changes in crude flows which occurred during 1972. Highlighted below are the key changes for the six domestic refining areas which account for approximately 85 percent of PAD I-IV crude production and refining.

Major Changes in PAD I-IV Crude Flows
(MB/D)

Refining Area	Local Production	Local Domestic Exports	Local Imports Domestic	Local Imports Foreign	New Supply
Mid-Coastal	--	--	-310	256	-35
Lake States	-9	-7	18	70	86
Kansas	-13	-9	15	4	16
Oklahoma	-18	0	-45	--	-62
Louisiana	-107	-300	31	4	228
Texas	215	-26	-60	16	198
	68	-342	-351	350	431

Source: U. S. Bureau of Mines

As indicated above, PAD I-IV experienced an increase of about 430 MB/D in new crude supply (or 44 percent over 1971 levels). Despite this growth, a significant shift in crude supply patterns occurred:

- Crude production declined in three key states whose refineries typically depended on local crude supplies (Kansas, Oklahoma and Louisiana).

- To maintain local refining rates (in Kansas and Oklahoma) or to support increases in local refining (Louisiana), these three states decreased domestic exports to other areas; in addition, production increases in Texas and a share of shipments to other PAD's were diverted to expand local refining.

    -- The large decline in Louisiana shipment is particularly significant because of its low-sulfur characteristics;

    -- The biggest loser of Louisiana sweet crude was PAD I. Louisiana shipments accounted for 70 percent of PAD I's total domestic loss; this loss represented about 15 percent of PAD I's crude supply during 1972.

- These domestic crude-lossing areas increased their use of foreign crude; on balance, however, PAD I experienced a net decrease in new supply while PAD II managed only a slight gain.

The increased use of foreign crude, principally in PAD I and II, consumed 42 percent of the non-U.S., free world increase in crude production. Because these imports needed to replace the loss of Louisiana crude, which is sweet, the U.S. imported 106 percent of the free world increase in sweet crude production. Finally, these events in PAD I-IV were compounded by a large crude import increase in PAD V, as shown on the following page:

1972: U. S. Share of Increased Free World Crude Production
(MB/D)

Imports	Sweet	Sour	Total
PAD I	220	30	250
PAD II-IV	80	20	100
PAD V	80	70	150
Total	380	120	500
Free World Production	360	850	1,210
U. S. Free World	106%	15%	42%

Source: U. S. Bureau of Mines and International Petroleum Encyclopedia

In addition, this import growth fell mainly on countries outside the Western Hemisphere. More importantly, it caused free world crude markets to tighten generally and markets for sweet crude to tighten severely. The major impact of tight sweet crude supplies mainly affected the mid-coastal refining centers within PAD I.

c. Structural Changes in Domestic Refining

The volume and regional distribution of domestic refining, as well as levels of crude stocks, followed the changed domestic pattern of crude supply. Table 3, at the back of this section, shows the changes in refining and crude stocks which occurred during 1972. The key features of Table 3 are summarized on the following page:

1972: Changes in Refining and Crude Stocks
(MB/D)

Area	New Crude	Stock Change	Refinery Runs
Mid-Coastal	-35	-6	-30
Lake States	86	-2	87
Kansas	16	-2	3
Oklahoma	-62	-1	-7
Louisiana	228	3	211
Texas	198	2	125
	431	-6	389

Source: U. S. Bureau of Mines

As shown above, two major changes in domestic refining occurred:

- Refining and crude stocks in the Mid-Coastal area, which accounts for the bulk of PAD I refining, followed the decline in new crude supply; this decrease represented approximately 3 percent of 1971 crude runs in this region.
- A shift in the distribution of PAD I-IV refining occurred, primarily because Louisiana and Texas together accounted for 85 percent of the total increase in PAD I-IV refining.

During the year, however, the tight crude supply situation focused on mid-continent refiners, particularly in Kansas and Oklahoma. In these two states, small "independent" refiners experienced acute crude supply problems; as a result their refineries operated at reduced rates. Four things combined to affect these particular mid-continent refining operations:

- Crude production from local fields declined.
- These refineries normally obtained their crude supply directly by way of gathering lines from local fields where production was declining -- few of these refineries had connections to the few major crude pipelines transiting their area.

- Even if connection were available, the direction of flow of these crude pipelines were outbound rather than inbound; in addition, these lines terminated in equally crude-pinched refining areas (e.g., the Lake States), which had a limited ability to offset crude diverted to mid-continent independents with increased crude imports.
- These refineries' potential to adapt to new crude was limited. Their metallurgy and lack of desulfurization capacity prevented the use of high sulfur crudes.

c. Changes in Refining Slates

The previous discussion of demand changes indicated that gasoline and distillate demand grew in nearly equal volume amounts during 1972. To accommodate this equal volume growth from domestic refineries (given the typical two-to-one ratio of gasoline to distillate yields domestically) would have required distillate yield increases, obtained in at least several ways:

- Lower gasoline yields on crude, perhaps offset with greater amounts NGL blending;
- Lower yields of other middle distillates (e.g., kerosine or jet fuel); and
- Lower yields of heavy products (e.g., residual) through more severe refining.

In fact, gasoline, distillate, kerosine, jet fuel, and residual yields made up the same overall fraction of crude runs in 1972 as in previous years. Within the total, however, middle distillate yields shifted -- kerosine and jet fuel yields decreased to the benefit of distillate fuel oils -- and total gasoline outputs were boosted not by changed yields on crude but rather by increased NGL blending. In combination, these changes caused outputs of gasoline, distillate and residual to grow equally percentage-wise, which produced gasoline and distillate volume increases in their historical two-to-one proportions.

Within each refining area of PAD I-IV, refining strategies shifted differently in response to changed refining patterns and demand growth of individual products. Table 4, at the end of this section, details these changes. The table indicates the contribution to changes in output provided by (1) runs of crude, reruns and NGLs, (2) altered yields on crude, and (3) altered NGL blending rates. The changes indicated in Table 4 are meaningful only in detail; consequently, its highlights are not shown here. Four major points, however, emerge from inspection of Table 4:

- Overall, 84 percent of the PAD I-IV increase in "3-product output" (gasoline, distillate and residual) resulted from increased crude runs, 10 percent from increased yields (nearly all at the expense of kerosine and jet fuel) and 6 percent from increased NGL blending (all of which went to gasoline output).

- East Coast, however, had a slight 3-product output decline; in order to manage a slight increase in gasoline output and to overcome a decline in NGL blending, it cut heavily into outputs of all other products and especially of distillate. Of course, this could be expected due to the ease of importing distillates into PAD I compared to, say, PAD II.

- Principally Louisiana, and to a lesser extent Texas, replaced lagging East Coast outputs of both gasoline and distillate; to do this, however, they reduced residual yields slightly and kerosine and jet fuel yields more so.

- PAD II basically followed the overall PAD I-IV refining pattern, except that distillate and residual yields increased at the expense of gasoline, kerosine and jet fuel. To obtain increased net gasoline output, the volume of NGL's blended increased by 52 percent; concurrently, NGL blending in Texas and Louisiana decreased by about an equal volume amount.

From the perspective of searching out the changes on the margin which produced the mild shortage situation, two points stand out from detailed product output data. First, the output gains occurred where the new crude supply increased -- in Texas and Louisiana; also, the refining slates in these areas generally did not slight distillate to make gasoline. In crude-pinched areas, however, gasoline output rates were increased by refining changes. Where possible, NGL blending was increased to allow simultaneous gains in distillate and residual. Otherwise, principally in the East Coast Region, distillate output declined in favor of gasoline. This had three implications for product logistics:

- Because overall PAD I-IV three-product output increased more slowly than demand, either product stocks or product imports had to make up the difference. The biggest percentage losses occurred with respect to distillate, residual, kerosine and jet fuel on the East Coast.
- Generally, product flows out of Texas and Louisiana needed to increase to make up shortfalls, principally in the East Coast but also to a lesser extent in other regions.
- Even in Texas, rather modest output gains -- compared to other areas product needs and allowing for local demand growth -- pinched supplies.

d. Structural Changes in Products Flows

Table 5, at the back of this section, details the changes in products flow implied by the changes in refining patterns and product outputs described above. Since the changes are meaningful only in detail, its highlights are not shown here. Three major points, however, emerge from the table:

- The gap between gasoline demand and local production in PAD I was made up by an increase in gasoline shipments from PAD III; this effect, however, was partially offset by increased shipments from PAD I to PAD II. Consequently, PAD I stocks declined by 10 percent against a 6.5 percent demand increase.
- Overall, PAD I-IV distillate demand grew twice as fast as distillate output; as a consequence, stocks declined in PADs I, II and III. Of particular note is the apparent absence of an increase in PAD I and II distillate imports.
- The PAD I residual demand gain, which accounted for 88 percent of the total PAD I-IV residual demand growth, was supplied almost entirely from imports and stocks. This caused residual imports to PAD I to increase by about 11 percent.

e. Changes in Products Imports

Table 6, at the back of this section, describes the changes in distillate and residual imports during 1972.[1/] The key changes in distillate imports and their implications for the means of providing these imports are summarized in the table on the following page:

[1/] Available products imports data are extremely weak as initially reported; final revisions occur slowly and often change original reports by amounts far in excess of the incremental quantities pointed out by Tables 5 and 6. Additionally, finally revised data are not reflected back into the presentations from which Table 5 was drawn; unrevised 1971 import data account for the lack of correspondence in import quantities shown in Tables 5 and 6.

Changes in Products Imports

	Percent Increase in U.S. Imports	Destinations of Imports	
		PAD I	PADS II-V
Distillate			
North America	380%	14.8%	2.0%
Caribbean	26.2	74.8	-11.1
South America	-8.7	-27.3	5.0
Europe	116	39.8	.1
Total: Percent	19.0%	102.4%	- 2.4%
Residual			
North America	140%	31.1%	1.3%
Caribbean	8.7	41.4	-6.4
South America	2.7	- 7.5	5.2
Europe	25.7	14.4	1.9
Total: Percent	10.4%	97.2%	2.8%

As indicated above, two major changes in import patterns occurred:

- Declines or slow growth in imports from South America (principally Trinidad and Venezuela, which supplied 44 percent of distillate and 45 percent of residual imports in 1971) required large volume and percentage increases in imports from the Caribbean and Europe, especially for distillate.
- Nearly all of the increase went to PAD I; in the case of distillate, PAD I actually diverted supplies previously imported to other PADs.

It is important to note that these gains represent import growth preceding the surge of European imports -- particularly of distillate -- which occurred during the first quarter of 1973.

5. SUPPLY EVENTS DURING FIRST QUARTER - 1973

The supply events during 1972 focused principally on PADs I-IV, these events related mainly to the mild distillate shortage which occurred in the fourth quarter of 1972. During the first quarter of 1973, the focus changes to the events which affected the gasoline shortage which commenced at the retail level in mid-April, 1973.

Our general approach to the first quarter of 1973 is identical to that for the 1972 year. Selection of a base comparison period, however, is more difficult. The comparison here is made with the first quarter of 1972. In an attempt to allow for the changes which occurred in supply patterns during 1972, we also include the fourth quarter of 1972 as a reference point.

a. Changes in Demand, Refining and Product Flows

Table 7, at the back of this section, shows the detailed changes in demand, refining and product flows which took place from the fourth quarter of 1972 through the first quarter of 1973, both compared to the identical periods during the previous year. As indicated by the table, the first quarter showed domestic production and demand moving in opposite directions.

Typically, the first quarter supply exhibits a drawdown of heating oil stocks to their annual low point and a simultaneous buildup of gasoline stocks to their yearly peak. Also during the first quarter, refineries shift their yields to emphasize gasoline. In contrast, the first quarter of 1973 evidenced a buildup of heating oil stocks -- from both domestic production and a surge of distillate imports -- and a drawdown of gasoline stocks to below-normal levels.

Several additional aspects of first-quarter, 1973 events are important:

- Europe accounted for 55 percent of the first quarter distillate imports and the Caribbean for 38 percent; South America avoided a net decline only by offsetting decreases in Venezuela and Trinidad with increases in Brazil and Columbia.
- The net result produced stock positions on March 31, 1973 which were 8 percent lower for gasoline but 14 percent higher for distillate than at the same time in 1972.
- Had refinery yields on crude during the first quarter of 1973 followed the 1972 pattern, gasoline stocks would have equalled stocks at March 30, 1972 and distillate stocks still would have exceeded prior year levels; further, if NGL charging maintained first-quarter 1972 rates, gasoline stocks would have been about 5 million barrels higher than the similar period of 1972, as shown below:

Impact of 1Q, 1972 Yields on 1Q, 1973 Output

	Percent Yields in Crude		Output		Change
	1Q72	1Q73	Adjusted	Actual	
Gasoline	46.52	44.72	502407	485638	16769
Distillate	24.16	25.17	225269	234694	(9425)
	70.68	69.89			

C. EFFECTS OF GOVERNMENT POLICY ON FUEL SHORTAGES

The preceding portions of this section described the events surrounding 1972-73 gasoline and distillate shortages, against the background of supply trends which developed since 1966. The U. S. oil industry is subject to extensive government policy influences, which affect both the supply and demand for oil. The connections between these government activities and policies and tight gasoline and distillate supplies during 1972 are discussed here.

1. OVERVIEW

The introduction to this report described the evolutionary nature of U. S. oil supply and demand events from 1966 through 1973. The industry changes which occurred happened gradually over this seven year period. Over the same period, government actions and policies affecting oil supply and demand also changed gradually.

U. S. oil supply and demand resist abrupt change. This occurs because of the long leadtimes inherent in consumption and supply patterns for all forms of energy. These long leadtimes, and the slowly evolving nature of the U. S. supply-demand balance and energy policies in response to these leadtimes, make it difficult to identify specifically the connections between government policy and supply and demand events. The key analytical issue is how to pinpoint the private investment and policy decisions which led to the 1972-73 shortages, to identify when these decisions were made, and to determine whether government policies existing at that time or expectations of future policy changes drove those decisions. To make this connection requires a framework for understanding the nature of the oil supply and demand processes and the key government activities and policies related to each.

2. THE OIL SUPPLY PROCESS AND GOVERNMENT POLICY

a. Crude Production

Crude production is the pivot point in the process of creating a supply of oil products. Crude production is preceded by a drawn-out process of exploration for and development of petroleum reserves. This process of creating reserves represents the long run investment of the oil industry; also, the results of these steps -- production -- is long-lived, since producing fields typically have economic lives of more than 20 years.

This production investment requires large expenditures and exhibits a high degree of uncertainity. For example, during 1971 -- which represented a low point in domestic oil exploration -- exploration absorbed 22 percent of the total petroleum industry investment in the U. S.[2/] An additional 34 percent of the industry's U. S. investment was absorbed by development of known reserves and crude production.

b. Refining, Transportation and Marketing

Downstream from crude production, oil supply investment occurs stepwise -- each succeeding investment decision (e. g., crude transportation, refining, products transportation, etc.) depends on its predecessors. At each step in the supply system, the investment involves large dollar commitments and multi-year leadtimes and results in plant and equipment which is fixed permanently in place. For 1971, downstream investment accounted for the following shares of the industry's U. S. investment: refining (14 percent); crude and products pipelines and tankers (9 percent); and storage, distribution, and point of sale investment (21 percent).

In addition, downstream investments typically represent large unit-investment decisions; for example, an economically-sized grass roots refinery of 200 MB/D capacity can cost $175 million; the accompanying refinery siting and crude source decisions can imply large pipeline and tanker investment decisions. Given

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[2/] Source: Chase Manhattan Bank

the long-lives of these large investments, the risk is high. Also, the physical permanance of these facilities and the predominantly fixed-cost nature of refining and transportation, imposed by their large capital requirements, increase risk.

c. Government Policy Factors

Collectively, the petroleum supply decisions span long planning horizons, again because the investment leadtimes are long and because the resulting producing fields, refineries, pipelines, etc. are long-lived. As a result, decisions are based on expectations over a long future period; consequently, uncertainty concerning demand, the supply of resources, and the economic environment bear heavily on investment decision-making.

This petroleum supply investment process operates under extensive and complex governmental policy forces. These policies fall into two broad categories. The first includes tax policy, import controls, and so-called "conservation" controls (specifically, market-demand prorationing). The second category relates to leasing of mineral rights on Federal lands and the outer continental shelf (OCS).

Historically, the first group of policies took the form of a government-sanctioned domestic crude supply cartel. Typical of any cartel, its economic incentives have been peculiar and distinct from economic principles associated with classical free market economic theory. 3/

3/ The existence of a crude supply cartel itself does not indicate petroleum industry monopoly. The industry could be extremely competitive despite government-sanctioned supply controls, although prices would not reflect what could be expected under "free market" conditions. For example, high domestic crude prices stemming from these supply controls appear not to have led to monopoly profits, principally due to economic rents in the form of large payments to land holders in the form of lease bonsues, a principal beneficiary of which have been governments.

This system of U.S. supply control policies root in common law -- specifically the rule of capture applied in the U.S. to migratory mineral deposits; in the peculiarities of reservoir mechanics; in the supply instabilities caused by the unpredicted discovery of large oil fields over time; and in the relatively inelastic nature of demand. Ostensibly, these policies arose to stablize crude prices in light of these four factors related to the oil business.

The "balance wheel" among these policies -- prorationing -- originally evolved to curb wasteful drilling and production practices caused by the physical nature of petroleum reservoirs and the rule of capture. Later, market-demand prorationing evolved to control the effects of a large and unpredictable crude supply additions generated by liberal tax provisions and, again, reservoir mechanics and the rule of capture. In turn, import quotas became necessary to control increasing crude imports; without quotas market-demand prorationing would not have operated effectively. Yet, the high domestic crude prices and high domestic crude production costs resulting from market-demand prorationing stimulated import growth by making the import of cheap foreign crude under the prorationing-supported umbrella of high priced domestic crude attractive. This conflicting but interelated nature of supply controls is confirmed by the fact that import controls were imposed at the same time large, excess domestic crude supplies were overhanging the market (constrained by market-demand prorationing), but at prices in excess of foreign crude.

The interlocking, mutually-reinforcing nature of this system of domestic crude oil supply controls made reform difficult until the fundamentals of domestic crude supply changed. For example, the domestic over-capacity for crude production needed to erode before market-demand prorationing could be relaxed. In turn, relaxation of market-demand prorationing was necessary to allow reform of import policies. This system of domestic supply controls began to unfold during the 1966-1971 period.

3. OIL DEMAND AND GOVERNMENT POLICIES

a. Interfuel Competition

U.S. oil demand occurs within the framework of total domestic demand for energy. The domestic mix of energy (e.g., oil, gas, coal, electricity, etc.) is determined by interfuel competition. Additionally, oil demand is subdivided by product categories (gasoline, distillate, etc.) and within categories by product specifications (e.g., octane value, sulfur content, etc.).

This interfuel competitive process creates short-term as well as long-term substitutions to occur between fuels. The basis of competition includes technical factors, resource and processing cost factors, and transportation cost factors of a technical and a geographical nature. Consequently, the interfuel competition process is complex and is subject to a wide variety of technical, economic, and logistical considerations.

Given a level of total domestic energy demand, various features of the interfuel competitive process affect the demand for each oil product. First, certain crude-based products -- particularly gasoline -- have a competitive niche which is protected from substitution effects, except in the long run. Other oil products -- principally heating fuels -- have faced varying degrees of competition regionally. For example, substitution of residual for coal in steam-electric plants in the Northeast depended on geographical advantage (water access and the transportation costs involved in supplying gas and coal due to the lack of local supplies). Finally, some crude-based heating fuels are subject to short-term substitution effects; the growth in distillate demand for turbo-fuel in response to natural gas shortages illustrates this type of effect.

In addition, increased distillate demand caused by natural gas curtailments indicates that oil's place in the interfuel competitive process is connected to the supply availability of substitute fuels. Oil demand also is related to government supply policies for oil. For example, residual fuel's competitive position in the Northeast steam-electric plant market grew only after PAD I residual import restrictions were relaxed (in 1966).

This description of the demand process brings out several points:

- Crude demand exists within the framework of total energy demand.
- With this overall demand, crude's position depends on a complex interfuel competitive process which can vary geographically.
- This competitive position, of course, is interrelated with crude supply. More importantly, it is tied to the supply process for competing fuels; some of these fuels (e.g., associated dissolved gas) are joint products of crude supply.
- This interfuel competitive balance is subject to both short-term and long-term changes.

b. Government Policy Factors

Similar to crude supply, crude demand is subject to various government policy forces. Total U.S. energy demand is affected by general economic conditions and a system of resource policies for all fuels which have tended to keep energy costs low. These general policies determine a"base" demand for oil.

This "base" demand, however, is modified by policies aimed at competing fuels. The key policy directed at other fuels but which affects oil demand is the regulation of wellhead prices of natural gas intended for interstate sale. Recent increases in the demand for oil -- stemming from curtailed natural gas supplies -- result from this policy. Of parallel interest is the fact that the low gas prices which decreased gas supply affect oil production adversely. Conversely, oil production affects gas production; consequently, oil supply can be retarded somewhat at the same time that decreased supplies of low-priced natural gas are increasing oil demand.

Oil demand also is affected by policies only indirectly related to supplies of competing fuels. Environmental regulations have increased oil demand through sulfur emission limits applied to coal-burning power plants. Intertwined with this is the electric power industry's response -- switching to natural gas and oil rather than burning low-sulfur coal or installing stack-gas cleaning equipment to permit burning of high-sulfur coal. In these two examples, oil demand experienced two short-term substitution increments to its base demand: coal-to-oil (principally affecting residual) and coal-to-gas-to-oil (principally affecting distillate).

4. NATURE OF THE ANALYTICAL PROBLEM

It is difficult to connect recent gasoline and distillate shortages to specific government policies. Three problems are involved:

- The 1972-73 gasoline and distillate shortages were slight and were a final outcome of a drawn-out process of eroding supply safety margins. Consequently, the problem is to estimate which policies did one of three things:
    - -- Caused the gradual development of a marginal oil supply situation overtime;

  - Tipped the supply-demand balance to initiate the specific shortages of 1972-73; and

  - Constrained the resolution of the supply-demand imbalance during 1972-73 as well as over the moderate to longer term.

- Oil supply and demand leadtimes generally are long; yet, short-term increments in demand did occur (e.g., the substitution between natural gas and distillate or residual). Three questions arise:

  - Were the shortages caused by the secular events over the 1966-1971 period or by the short-term demand increments?

  - In either case, at what point in time were the decisions made which led eventually to the shortages?

  - Were the policies in effect then or expectations concerning future policies responsible for these decisions?

- A number of policy intangibles undoubtedly played a large role. For example, the long planning horizons, the transitional nature of the domestic energy balance and energy policies, and the magnitudes of investments required (coupled with the high fixed cost nature of the oil industry) created a high level of decision-making uncertainty and risk.

Because of these analytical problems our assessment here is judgmental and simplified. Exhibit I-1 shows ten policy areas which we believe played a key role related to the 1972-73 shortages and our assessment of the way in which they affected the shortage situation along three lines:

- Those that caused the marginal supply situation to develop over time.

- Those that limited the immediate response.

- Those that constrain the moderate to long-term response.

EXHIBIT I-1

Government Policies and Their Effects on Current Shortages

Government Policies	Contributed to Marginal Supply Situation	Limited Immediate Response	Limit Moderate to Long-Range Response
• General Economic Conditions	x		
• Transport/Urban/General Resource Policies	x		
• Natural Gas Regulation	x		
• Tax Treatment	x		
• Market-Demand Prorationing	x		
• Import Quotas	x		
• OCS Leasing	x		
• Environmental Policy and Regulation		x	x
• Economic Stabilization Program		x	
• Voluntary Allocation Program		x	

5. POLICIES WHICH INDUCED A MARGINAL OIL SUPPLY SITUATION

Five areas of government policy -- given general economic conditions and long-standing transportation, land-use, and overall resource policies -- caused the gradual erosion of oil supplies preceding 1972. These were natural gas regulation, tax treatment, market-demand prorationing, import quotas and OCS leasing.

a. Declining Domestic Crude Capacity

From 1962 through 1967 incentives for increasing domestic crude capacity were unfavorable. Economic incentives for domestic exploration, development, and increasing and maintaining capacity of producing wells were reduced for three reasons:

- Reduced well allowables and administrative treatment of multiple completions, both features of market-demand prorationing;
- Rising costs of drilling new wells;
- Unfavorable prospects for oil price increases.

During 1967, market-demand factors were low in the major producing states of PAD I-IV (Texas and Louisiana); domestic crude production capacity remained substantial relative to the size of the U. S. market. Due to exemptions permitted under these prorationing systems and treatment of multiple completions, market-demand proration constraints fell mainly on the most efficient fields. These restraints reduced the financial attractiveness of exploring for and developing flush reservoirs by delaying production from the most efficient fields.

While prorationing delayed the receipt of revenues from flush fields, "front-end" exploration and development investment requirements were increasing. First, general inflation was increasing the cost of drilling, equipping, and maintaining new wells. Secondly, well drilling costs were increasing due to a shift to offshore oil provinces and to greater depths onshore.

Finally, the outlook for price increases was pessimistic. In constant dollars, domestic wellhead prices for crude had been stagnant or declining in PAD III since 1957. This was coupled with overhanging domestic surplus crude production capacity. Finally, the political danger of increasing prices was evident from Federal Trade Commission rumblings in response to hikes in foreign crude prices occasioned by the 1967 Arab-Israeli conflict.

At the same time economic factors were unfavorable, prospects for onshore exploration were declining in the "lower-48". Simultaneously, the U. S. Department of the Interior tended to have a stingy view concerning offshore leasing. This view stemmed from the same reduced allowables-excess capacity situation affecting the overall economics of domestic exploration and development.

b. Response of Domestic Crude Supply to Related Supply Controls

After 1967, market-demand factors and domestic prices began to increase; the rate of increase accelerated through 1971. The "apparent" excess domestic crude production capacity, however, disappeared quickly. This occurred for four reasons:

- Production capacity per barrel of reserves had decreased during the 1960 period due to wider well spacing (i. e., less wells were used to develop a reservoir). Onshore, this occurred due to reform of previous depth-acreage allowables schedules. Offshore, this was caused by high well drilling, equipping, and operating costs.

- Due to calendar day testing practices employed in establishing allowables, many wells were operating more nearly flat-out than appeared when subject to a low market-demand factor.

- Conversely, for a few giant, flush fields, the top schedule allowable represented a production rate substantially below their MER's.

- After allowables changed, there is a time delay required to perform well workovers and to install better equipment and gathering lines.

c. Response of Import Supply to Inadequate Domestic Supply

A reliable crude supply system would respond promptly to offset declining domestic supplies with imports. Especially in PAD's I-IV, the import response was constrained "automatically" as domestic production declined. This occurred because import quotas were fixed as a constant percentage of domestic crude production. Although supplemental quotas were avilable where automatically scheduled imports were insufficient, the appeals process for supplemental quotas represented an administrative bottleneck. (PAD V, because it always was viewed as a crude deficient region, lacked market-demand prorationing; also, import quotas were tied to demand rather than crude production. This provided greater short run import flexibility there).

Generally, the government was not favorably disposed toward increased imports. For example, during the period of increasing need for imports, the U. S. placed its crude supply relationship with Canada in jeopardy. For a considerable period of time Canadian imports in excess of quota levels had been ignored. About 1970, the U. S. threatened not only to enforce Canadian quotas but also to put Canada on an equal footing with other countries by removing its "overland exemption".

Finally, there was a general reluctance to deal with the Eastern Hemisphere producing countries. On the government side, embargoes during the 1967 Arab-Israeli conflict raised security questions. On the company-side, early warnings appeared, pointing to the events which surfaced formally during the Terhan Agreement of 1971.

Finally, difficulties were encountered with Venezuela, the remaining major U.S. crude supply point in the Western Hemisphere. Expirations of U.S. company concessions and production contracts, announced for 1980, reduced company incentives to invest in maintaining and upgrading the productive capacity of Venezuelean fields.

d. Declining Domestic Gas Supply

Over a long period, the well-head price of natural gas intended for interstate transmission was regulated substantially below intrastate price levels. In response, interstate gas supplies did not keep pace with gas demand. To complicate this situation, interruptible gas customers prepared for curtailments by installing oil-burning equipment. Also, the domestic incentives acting against crude supply increases acted directly (in the case of associated gas) and indirectly against the gas supply. As discussed previously, these joining effects magnified oil demand.

6. POLICIES WHICH LIMITED THE IMMEDIATE RESPONSE TO FUEL SHORTAGES

As described earlier, the intrinsic nature of the oil demand and oil supply processes limit the rate at which demand-supply adjustments can occur. As a result, the policies which originally eroded safety margins could be expected to amplify a shortage situation for some period beyond when actual shortages occurred. Nonetheless, at least three areas of government activity limited the supply and demand adjustment process during 1972 and 1973. These were price controls, voluntary allocations, and environmental regulations.

a. Continued Effects of Policies Which Eroded Safety Margins

As indicated above, inertia in the supply and demand processes for oil and for substitute fuels caused any supply demand imbalance to amplify for a period after shortages first appear. In particular, the increasing cumulative effects of two long-standing policies -- natural gas price regulation and the mandatory oil import program worsened the shortage situation through 1972 and 1973.

Natural gas curtailments, related to interstate shipments affected by Federal Power Commission price regulation, increased in 1972 and 1973, especially in the East Coast market. On an equivalent BTU basis, approximately thirty percent of these curtailments fell on oil-based heating fuels. During the 1972-1973 heating season, where the first shortages appeared and affected distillate users, natural gas curtailments accounted for approximately twenty percent of increased distillate demand.[4]

A second government activity which limited supply response centered on supplemental crude quotas. By design, the import quota system automatically decreased import availability for PAD's I-IV as domestic production declined. This feature of the program simultaneously increased the need to obtain supplemental import quotas, which caused the government to become involved heavily and directly in crude supply decisions on a short-term basis.

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[4] Source: Federal Power Commission and Department of the Interior.

Beginning in the second quarter of 1972, an increase occurred in advisory requests for PAD I-IV supplemental quotas to cover the balance of the year. No substantial government action was taken with respect to supplemental allocation requests until mid-December. By that time, leadtimes required to nominate, lift, and transport additional foreign crude combined with tightened world crude markets to delay the response of crude imports until the second quarter of 1973.

A similar pattern of inflexibility in the oil imports quota system occurred with respect to refined products. In the case of distillate, requests for relaxation of distillate imports quotas were made in the second quarter of 1972 but generally did not get acted upon until mid-January, 1973.

b. Effects of Economic Stabilization Policies

During 1972 and early 1973, price controls -- applied under the Economic Stabilization Program -- complicated the oil supply response capabilities. From mid-1971 through the first quarter of 1973, price control policy underwent three phases. The key phase of price control policy affecting oil supplies was Phase II. First, Phase II excluded crude, gasoline and distillate from Term Limited Pricing. This exclusion, combined with administrative bottlenecks in seeking specific product price increases were these exclusions applied, froze crude, gasoline and distillate prices at Phase I levels for all practical purposes.

Secondly, Phase II froze all product prices at mid-summer levels. Both gasoline and distillate prices exhibit seasonality, with distillate prices exhibiting the larger price swings. This seasonal variation occurs because of distillate's more extensive seasonal demand variations and the refiners' practice of using distillate stocks to level refinery yields over the year. As a result, summer distillate prices -- at the refinery gate -- typically are discounted to encourage off-season stock building in the distribution channels by compensating dealers' inventory carrying costs. Conversely, winter season prices typically rose in response to increasing heating consumption.

Consequently, Phase II froze gasoline and distillate prices at their point of maximum (summer) price differential. During the winter of 1972-1973, this effect was confirmed by price spreads evidenced at the wholesale level between gasoline and distillate. Specifically, at major Gulf Coast refining centers wholesale margins between gasoline and distillate were sixty percent greater than during the same period in 1971-72. The result was a bias in domestic refining economics favoring gasoline at the expense of distillate.

Freezing distillated prices also failed to reflect events related to import prices for distillate. By the middle of the 1972-1973 heating season, domestic distillate prices were controlled below prevailing world price levels. Domestic sellers with their own domestic distillate supplies potentially had to import some fraction of their supply at world prices exceeding frozen domestic price levels. This caused an import disincentive, but these types of sellers at least could average higher priced imports over their domestically-refined supplies.

Importers without their own domestic supplies, however, were effected more seriously by domestic prices frozen below world price levels. First, the traditional domestic supplies available to these importers decreased, because domestic refiner-marketers kept their own domestic distillate rather than offer it to resellers wherever such sales would have had to be replaced with imported distillate. This caused the average cost of the distillate supplies of importers without domestic sources to rise nearly in proportion to world distillate prices. Without price controls, these suppliers would have experienced at least a competitive disadvantage in terms of price; with controls, their losses per barrel were disproportionally high. These effects primarily fell on the independent distributors, which accounted for a large share of the distillate market on the East Coast.

Although modifications to price controls dealing with resellers attempted to correct this situation, delay and ambiguity minimized the relief available to them. Moreover, reseller rules did not decrease the incentives of domestic refiner-marketers to retain their own distillate supplies.

The same outline of the price situation with respect to imported distillate applied to imported crude. For crude, the effect of price controls fell mainly on independent refiners in the Mid-Continent. These refiners felt more fully the effects of higher-priced foreign crude because they had the smaller amounts of domestic crude -- particularly of their own -- over which they could average higher-priced foreign crude inputs. Similar to independent distillate distributors, price controls also decreased independents' domestic crude sources by creating incentives for majors to keep their domestic crude rather than to sell their domestic crude at controlled prices and to replace domestic crude with foreign crude priced above controlled prices.

Finally, the crude situation for independents was complicated further because these refiners often required low-sulfur crude (due to refinery metallurgy and to limited desulfurization capacity). With tight world markets for sweet crude, majors which sold low sulfur crude in the mid-continent, probably could only replace it with higher sulfur imported crude. Although these refiners often had adequate metallurgy and desulfurization equipment to refine higher-sulfur crude, the additional operation and maintenance costs associated with running high sulfur crudes could not be reflected in controlled product prices.

c. Effects of Allocation Policies

As distillate shortages began to appear at the end of 1972, the government began jawboning refiners on two counts -- maximizing distillate output and "equitably" allocating available supplies of crude and products. The direct effects of this jawboning are difficult to ascertain because of its intangible nature. In the case of voluntary allocations, however, the potential for making them mandatory discouraged sales by majors to independents. Specifically, retaining rather than selling crude and products during the voluntary period could increase "base-period" amounts of "own-supplies" not subject to allocation under any mandatory reallocation program.

With respect to distillate, the potential effect of the government's jawboning efforts are not clear. Perhaps, however, jawboning may have caused the delay in refinery shifts back to gasoline production during the first quarter of 1973, which produced gasoline shortages in the second quarter.

d. Effects of Environmental Activities

The influences of environmental activities on oil come from three sources:

- The National Environmental Policy Act;
- Regulation under the Clean Air Act Amendments of 1970; and

- Heightened public interest in and activity toward more sound environmental practices including citizen action, organized legal action, and governmental activity at the state and local levels.

All three sources affected oil demand and supply different ways and amounts.

We, however, do not believe that environmental activities were responsible in a fundamental way for the 1972-1973 shortages, for three reasons:

- The point where environmental policy began to most effect energy matters occurred after mid-1970; considering the leadtimes applying to the oil supply and demand process, it is difficult to assign 1970 events predominant weight on shortages during 1972.
- For almost any environmental impact on the 1972-1973 oil situation, there are several other policy factors which each contributed an equal amount to the shortage problem.
- In some cases, changes in other policy areas caused large corrections in the supply situation. For the short term, these illustrate that environmental policy may not have been the most compelling constraint; the announcement of refinery expansions simultaneous with changes in oil import controls illustrates this effect.

We do believe, however, that environmental considerations will complicate balancing oil supply and demand in the immediate, moderate, and long run. The key areas where environmental activities have and will effect oil supply and demand are as follows:

- Coal supply -- through sulfur limits, stripmining regulations, and slow private development and application of stack gas cleaning technology;
- Gasoline demand -- through auto emission limits and the emissions control technologies selected to date by the auto industry;
- Utility oil demand -- through the limits on coal supply outlined above;

- Crude oil supply -- through actions in the Santa Barbara Channel, delays in offshore leasing, and construction of trans-Alaskan pipeline;
- Refinery siting -- through local permitting delays, superport delays, and the crude oil supply problems outlined above; and
- Products supply -- through sulfur limits on refined products and desulfurization capacity constraints. (Particularly in foreign areas and in older, sweet crude-dependent refiners in the Mid-Continent.)

If every other aspect of energy supply and demand is taken as given, environmental constraints might be accused of tipping the oil supply and demand sufficiently to have caused the 1972-1973 shortages. For the purposes of assigning responsibility, however, the key problem is that, given a more ideal industry response to environmental controls, more appropriate longstanding governmental energy policies and either better planning or a more certain or less rapid implementation of environmental policy, environmental protection could have been accomodated with relative ease.

Table I-1

1972 Demand Growth: By Quarter*

	1972					1973
	1Q	2Q	3Q	4Q	Year	1Q
Motor Gasoline			--- MB/D ---			
I-IV	261	265	356	276	294	430
V	105	70	66	54	68	29
U. S.	366	335	422	330	362	459
			--- Percent ---			
I-IV	5.5	5.0	6.7	5.3	5.7	8.6
V	3.2	7.9	7.2	6.1	7.8	3.2
U. S.	6.6	5.4	6.7	5.4	6.0	7.8
Distillate			--- MB/D ---			
I-IV	83	153	123	483	245	66
V	10	5	2	20	7	31
U. S.	93	148	125	503	252	97
			--- Percent --			
I-IV	2.4	7.7	7.5	18.0	10.2	1.9
V	3.6	(1.9)	0.8	7.8	2.6	10.8
U. S.	2.5	6.6	6.6	17.0	9.5	2.6
Residual			--- MB/D ---			
I-IV	147	119	279	341	272	254
V	7	9	44	38	25	73
U. S.	154	128	323	579	297	327
			--- Percent ---			
I-IV	7.5	6.4	16.8	29.1	14.0	10.1
V	1.9	3.4	20.5	11.1	8.4	19.7
U. S.	5.6	6.0	17.2	26.3	13.3	11.3

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* Changes indicated for each quarter represent 1972 demand less 1971 demand during the same quarter. Computed from Bureau of Mines data.

Table I-2

Change in Crude Movements, 1972

(MB)

	Local Production	Interarea Shipments	Refinery Receipts Local	Refinery Receipts Interarea	Refinery Receipts Foreign	New Supply 3/
PAD I						
Mid-coastal 1/	--	--	--	(113,497)	93,510	(19,987)
Other	11,022	1,628	(1,437)	(467)	8,951	17,878
PAD II						
Lake States 2/	(3,407)	(2,630)	(623)	6,602	25,711	31,536
Kansas	(4,789)	(3,386)	(6,928)	5,628	1,468	5,693
Oklahoma	(6,429)	(75)	14,002	(16,328)	--	(22,682)
Other	(3,821)	1,108	(1,653)	(708)	4,947	(690)
PAD III						
Louisiana	(39,324)	(109,570)	65,232	11,219	1,666	83,131
Texas	78,615	(9,591)	64,381	(21,857)	5,845	72,194
Other	(8,876)	(11,428)	1,535	(810)	373	2,150
PAD IV						
All	(280)	11,577	9,893	(3,493)	(2,922)	(18,272)
PAD V						
California	(11,376)	5,354	(3,673)	1,491	30,750	15,511
Other	(6,197)	(9,722)	5,166	5,485	25,094	34,104
United States	5,138	(126,736)	135,713	(126,736)	195,393	200,531

-- Indicates amount produced, received, etc., is zero.

1/ Delaware, Maryland, New Jersey, and Eastern Pennsylvania.

2/ Illinois, Indiana, Michigan, Wisconsin, and Western Ohio.

3/ Represents approximate change in new supply = local production - shipments out + interarea refinery receipts and foreign refinery receipts. This ignores changes in stocks not at refineries and in transit.

Table I-3

Changes in Refining and Crude Stocks, 1972

	Crude New Supply 1/ (M/B)	Refinery Receipts 2/ (M/B)	Crude Refining		Percent Change
			Stock Change (M/B)	Crude Runs (M/B)	Crude Runs
PAD I					
Mid-Coastal	(19,987)	(19,987)	(2,374)	(10,831)	(2.6)%
Other	17,878	2,844	259	7,595	10.7
PAD II					
Lake States	31,536	31,690	(840)	31,837	4.3
Kansas	5,693	68	(622)	974	.7
Oklahoma	(22,682)	(2,325)	(167)	(2,474)	1.5
Other	(690)	2,586	68	2,374	1.7
PAD III					
Louisiana	83,131	78,118	972	76,993	17.7
Texas	72,194	48,368	(546)	45,533	4.3
Other	2,150	1,103	(35)	1,001	.7
PAD IV					
All	(18,272)	3,478	538	(2,468)	(2.5)
PAD V					
California	15,511	28,568	1,112	15,081	2.9
Other	34,104	25,413	(1,153)	27,439	25.2
United States	200,531	204,826	(2,788)	193,054	4.7

Computed from Bureau of Mines data.

1/ From Table 2.

2/ Lack of correspondence of new supply and refinery receipts reflects changes in stocks of other points and accounting weaknesses.

Table I-4

Changes in PAD I-IV Outputs of 4-Products, 1972

	Δ 1/ Crude + NGLs	Δ 2/ Yields on Crude	Δ 3/ NGL Blending	Total	Percent Change
		(M/B)			
PAD I-IV TOTAL					
Gasoline	84160	3006	9024	96190	5.1%
Distillate	36617	9359		45976	5.6
Residual	7405	3429		10834	6.5
Kerosine + Jet Fuel	13515	(16383)		(2868)	(0.9)
4-Products	141697	(589)	9024	150132	4.7
EAST COAST					
Gasoline	(2665)	9550	(1982)	4903	1.0
Distillate	(1428)	(3809)		(5237)	(4.3)
Residual	(364)	(329)		(693)	(2.2)
Kerosine + Jet Fuel	(257)	(3813)		(4070)	(18.3)
4-Products	(4714)	1599	(1982)	(5097)	(1.2)
PAD II (Except Kansas & Oklahoma)					
Gasoline	18966	(2880)	13963	30049	6.4
Distillate	7423	5183		12606	6.9
Residual	2166	3234		5400	10.1
Kerosine + Jet Fuel	2504	(1458)		1046	1.7
4-Products	31059	4079	13963	49101	6.4
TEXAS					
Gasoline	24662	(5043)	(8519)	11100	1.8
Distillate	10325	738		11063	4.4
Residual	1670	(894)		776	1.9
Kerosine + Jet Fuel	4667	(7445)		(2778)	(2.4)
4-Products	41324	(12644)	(8519)	20161	2.0
LOUISIANA					
Gasoline	45634	5370	(5810)	45194	17.0
Distillate	20799	5634		26433	21.8
Residual	2843	(733)		2110	12.7
Kerosine + Jet Fuel	11453	(6282)		5171	7.7
4-Products	80729	3989	(5810)	78909	16.8
ALL OTHER PAD I-IV					
Gasoline	(2437)	(3991)	11372	4944	1.5
Distillate	(502)	1613		1111	0.8
Residual	1090	2151		3241	13.2
Kerosine + Jet Fuel	(4852)	2615		(2237)	(5.6)
4-Products	(6701)	2388	11372	7059	1.7

1/ Δ crude x [yield(1971) + NGL + Crude(1971)]

2/ Total - Δ Crude + NGLs;

3/ Δ NGLs - [NGL + Crude (1971) x Δ Crude]

Computed from Bureau of Mines data.

Table I-5

Changes in PAD I-IV Product Flows, 1972-1971 [1/]

(MB/D)

	Local	Local	Receipts From			Shipped Out		Stock
	Demand	Output	Pad III	Other PADs	Imports	PADs	Export	Change
Motor Gasoline								
PAD I	132	16	96	2	9	15	--	(15)
PAD II	114	88	5	17	--	1	--	--
PAD III	59	137	--	(1)	--	93	--	(3)
PAD IV	(11)	7	(3)	(6)	--	12	--	(2)
Total	294	248	98	12	9	121	--	(20)
Distillate								
PAD I	72	(13)	62	0	(1)	6	--	(35)
PAD II	99	40	10	6	(1)	1	(2)	(39)
PAD III	72	93	--	1	0	71	(2)	(27)
PAD IV	2	(1)	(1)	(1)	--	(3)	--	(1)
Total	245	119	71	6	(2)	75	(4)	(102)
Residual								
PAD I	239	0	(6)	1	230	--	3	(8)
PAD II	35	19	7	--	4	--	0	(4)
PAD III	(2)	11	--	--	(14)	1	4	(3)
PAD IV	0	(2)	--	(1)	--	(1)	--	(1)
Total	272	28	(1)	0	220	0	7	(16)

[1/] Imbalances in flows accounting across rows represent reporting weakness. Additionally, imbalances in column totals and PAD I-IV total rows reflect minor flows to and from PAD V which are not shown.

Computed from Bureau of Mines data

Table I-6

Changes in Distillate and Residual Imports, 1972-1971

	Distillate		Residual		
	Pad I	Pad II-V	Pad I	Pad II-V	Total
	-------(MB)-------				
North America	1573	215	18648	799	21235 1/
Bahamas	1113	(68)	6495	408	7948
Netherlands Antilles	2324	(937)	3482	(4344)	519
Puerto Rico	1777	--	--	--	1177
Virgin Islands	3455	(170)	14363	(139)	17499
Trinidad	(1512)	(22)	9788	(268)	7907
Venezuela	(2669)	512	(4887)	3171	(4193)
Other Carribean/S. American	1153	37	56	237	1726
Europe	4223 1/	(2)	8640 2/	1157	14028
All Other	34	190	6512 3/	670	7365
	-------Percent-------				
North America	750*	98.6	143	87.3	148
Bahamas	331*	(100))	13.6	∞*	16.5
Netherlands Antilles	24.4	(65.6)	3.2	(56.1)	0.4
Puerto Rico	21.2	--	--	--	14.1
Virgin Islands	64.9	(100)	18.6	(100)	21.2
Trinidad	(37.9)	(6.9)	20.9	(15.7)	15.0
Venezuela	(13.2)	∞*	(2.3)	125	(1.8)
Other Carribean/S. American	197	∞*	(0.7)	817*	20.1
Europe	112	(100)	20.3	135	29.7
All Other	3.1	114	134	13.7	67.1
Total	20.4	(10.5)	10.4	8.8	11.1

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*Indicates changes in small quantities for 1971

1/ Principally Canada

2/ Principally Italy and Romania

3/ Principally Belgium, Spain, and USSR

4/ Principally Lybia and Nigeria

Computed from Bureau of Mines data

Table I-7

Key Changes in PAD I-IV Product Flows
4Q 1972 and 1 Q 1973

-----MB/D----

	Local Demand	Local Output	Receipts PADIII	Imports	Shipments Out	Stock 1/ Change
			4th Quarter, 1972			
Motor Gasoline						
I	108	30	134	3	26	37
II	129	105	(3)	--	8	(8)
III	49	138	--	--	109	(16)
Distillate						
I	147	45	141	2/	13	5
II	214	81	--	2/	(2)	(119)
III	116	182	--	2/	138	(74)
Residual						
I	417	(6)	(11)	423	1	(12)
			1st Quarter, 1973			
Motor Gasoline						
I	98	52	35	15	27	(28)
II	204	84	8	--	0	(84)
III	76	24	--	--	49	(96)
Distillate						
I	54	76	(50)	286	8	251
II	(63)	106	11	4	1	190
III	51	94	--	16	(38)	94
Residual						
I	161	13	(25)	159	(5)	1

1/ Stock change here represents the difference in stock change between the base and 1972-1973 period. Because the comparison periods are not adjacent, actual stock change is a meaningless number in this kind of analyses.

2/ Reported data are incorrect due to revisions to import data.

Computed from Bureau of Mines data.

SECTION II

OUTLOOK FOR GASOLINE AND DISTILLATE DEMAND AND SUPPLY

The preceding section described the tight gasoline and distillate supply situation during 1972 and early 1973. This section presents our estimates for gasoline and distillate demand and supply through 1976.

These estimates are presented in two time periods. The first period covers the third quarter of 1973 through the second quarter of 1974. These short-run estimates indicate the magnitude of the supply problem over the critical quarters where shortages occurred last year. The second period extends from 1974 through 1976. These moderate term estimates indicate whether or not planned domestic refinery construction is adequate to moderate the currently tight demand-supply situation. Refinery construction involves about a three-year leadtime. Consequently, new capacity likely to come onstream in 1977 is not announced yet; therefore, our estimates end at 1976.

This section first discusses the limitations of our demand and supply estimates and the policymaking implications of these limitations. Next, it presents our key conclustions. Then, it describes our estimating approach and presents our estimating results. Finally, it tests the sensitivity of our estimates to a variety of critical assumptions and, also, compares them with Department of Interior estimates, and discusses the vulnerability of U.S. supply to an interruption of imports. Several appendices are included at the end of the section; these provide backup to our estimates.

A. ESTIMATING PROBLEMS AND POLICYMAKING IMPLICATIONS

The main policymaking debate with respect to the short-run gasoline and distillate situation centers on whose estimates are correct. In our opinion, all recent estimates -- including our own -- are speculative. There are three reasons for this:

- In an area where trend extrapolation has been the key demand forecasting tool, recent "off-trend" product growth rates produce a high degree of forecasting uncertainty. Also, demand data are reported slowly, represent "apparent" rather than real consumption, and are not disaggregated well by using sector and quarter-year. Consequently, reliable statistical correlations of likely causes of demand growth are difficult to make and convincing forecasts based on casual trends (e.g., natural gas curtailment, and auto buying and using habits) are not available.
- Recently, domestic refinery capacity has been used atypically. Operating rates and yields have been "off-trend" on the high side. Whether or not recent operating parameters can be maintained is uncertain; this issue alone largely makes the difference between tight supplies and crisis.
- Because domestic refining currently is a major supply bottleneck and there is little safety margin built into either refining capacity or product and crude stocks, any undue optimism in estimating demand or supply reflects entirely into an import requirement. Even under optimistic domestic assumptions, the product imports required on a sustained basis are larger than those achieved heretofore. At these levels, our ability to forecast import availability is limited.

Basically, current demand and supply estimating data and techniques are derived from an era of surplus and near domestic self-sufficiency. The resulting limitations for the current period of shortage and import dependency are important to recognize. These have four implications for policymaking:

- Short-term policymaking should assume that current demand and supply estimates are speculative at the outset, even before allowances for normal contingencies such as abnormal weather or dramatic shifts in general economic conditions.

- There is little margin for estimating error built into domestic supply capabilities; a demand bulge and/or disrupted domestic supply reflect directly into import requirements, where knowledge of our supply capabilities is weak.

- Unless domestic self-sufficiency is imminent, any policy should deal with the need to make the necessary commitments to improve the reliability of the import supply as well as to correct the current import data and information deficit.

- Unless the total new supply is adequate to provide safety margins similar to past periods of surplus, domestic demand and supply data and estimating capabilities must be upgraded to the point where we can manage "close to the edge" with some greater degree of confidence.

B. KEY CONCLUSIONS FROM OUR ESTIMATES

Our analysis uses two indicators of the tightness of the gasoline and distillate supply situation. The first is the rate at which domestic refinery capacity operates.[5/] An industry-wide operating rate continually higher than 92 percent is considered "tight".

The second indicator is the amount of distillate which must be imported from areas where a share of the refinery capacity is not U.S.-dedicated. For example, the majority of Caribbean capacity is considered as U.S.-dedicated; Eastern Hemisphere capacity is treated as non-dedicated. As the U.S. products imports supply

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[5/] Operating rate indicates the percent of operable refinery distillation capacity being utilized. Here it is measured as the ratio of the volume of crude inputs to distillation units and the total capacity of all crude units. Capacity is defined as the amount actually available for use, after adjustments for inoperable units and an allowance for a normal amount of downtime.

begins to depend more on non-dedicated, Eastern Hemisphere countries, whose refineries are sized for local consumption and for whom the U. S. market traditionally has represented only an outlet for temporary surpluses of refined products, the reliability of our import supply decreases.

Based on these definitions of a tight supply situation, our major conclusions are that:

- For a "normal" 1973-1974 winter heating season, Eastern Hemisphere distillate imports must average about 280 MB/D at a 92.5 percent domestic refinery operating rate. If domestic capacity maintains the 94 percent rate evidenced for the first time during the second and third quarters of 1973, Eastern Hemisphere distillate import requirements decrease to 125 MB/D. A one-in-five colder than normal winter, however, could increase this requirement by 150 MB/D. This range of Eastern Hemisphere imports (125 MB/D-425 MB/D) compares to average imports from this area of 26 MB/D during 1972, 122 MB/D over the 1972-1973 heating season, and 211 MB/D during the first quarter of 1973.

- At the outset of the 1973-1974 heating season, distillate stock levels will be only slightly higher than at the same point in 1972. On a days supply basis, stocks will be 23 percent below 1971 levels at that point. Either a lag in fourth quarter 1973 distillate imports (which must be a stock maintenance or building period rather than a distillate draw down period, as is typically the case) or an early winter (similar to 1972-1973) will put opening stocks for the first quarter of 1974 at precarious levels.

- After a "normal winter" with 280 MB/D of Eastern Hemisphere distillate imports, a 92.5 percent domestic refinery operating rate, and a return to a 94 percent rate at the end of the first quarter of 1974, gasoline stocks at the end of the second quarter will be improved only slightly over their levels at the same point in 1972. Compared to 1971 levels, in terms of days supply, gasoline stocks will be 8.5 percent below normal at that point.

- In order to meet demand increases and to return gasoline and distillate stocks to normal levels, distillate imports from all sources must continue at high levels throughout 1974, (542 MB/D in total, 196 MB/D Eastern Hemisphere). These levels compare to 182 M/D on the average throughout 1972 from all sources and represent 93 percent of the rate required during the 1973-1974 winter heating season.

- Firm additions to refinery capacity, domestically and in the Caribbean, may moderate the distillate import situation somewhat during 1975 and 1976. Compared to 280 MB/D required from the Eastern Hemisphere during the 1973-1974 heating season, average annual imports from this area may be 160 MB/D in 1975 and 105 MB/D in 1976. In 1976, this requirement still equals about 340 percent of 1972 Eastern Hemisphere distillate imports. This requirement is also sensitive to domestic refinery operating rates and demand. A cumulative demand estimating error of 1 percent changes the 1976 requirement by 33 MB/D or 130 percent of the 1972 Eastern Hemisphere requirement. Alternatively a 1 percent change in the average annual domestic refinery operating rate changes the 1976 requirement by 30 MB/D, or 115 percent of 1972 Eastern Hemisphere imports.

1. FACTORS WHICH COULD MAKE OUR CONCLUSIONS OVERLY PESSIMISTIC

For our conclusions to be viewed as pessimistic, the critical assumptions which must be made are that:

- Substantial domestic refinery debottlenecking potential exists.

- Announced capacities of refineries now under construction are understated.

- Domestic refinery operating rates of 94-95 percent are feasible over long periods.

- Yields of gasoline and distillate can be increased 2-3 percent without serious supply implications for other products (principally special napthas and jet fuel) or that a reliable, economically viable source of imports exists for these other products.

- A reliable additional source of distillate imports can be developed in the Eastern Hemisphere or in the Western Hemisphere.

- Domestic refiners will begin to import significantly greater quantities of gasoline (other than from Puerto Rico) and that sources of U. S. -compatible gasoline exist.

- Our demand estimates are too high, due to some utility conversion back to coal, increased natural gas supplies, a decreased rate of economic growth, changed auto-buying and auto-using habits, a substantial demand response to higher fuel prices or successful implementation of energy conservation measures.

2. FACTORS WHICH COULD MAKE OUR CONCLUSIONS OVERLY OPTIMISTIC

For our conclusions to be viewed as optimistic, the critical assumptions which must be made are that:

- Crude supplies, for all grades of crude but especially of sweet crude, are tight domestically and in the Caribbean.

- Reported stock levels hide a potential supply problem facing independent distributors, whose stocks are not reflected even though they play a major role in many East Coast markets.

- Caribbean distillate output available to the U. S. is over-estimated.

- European distillate available to the U. S. (as indicated by import levels achieved in the first quarter of 1973) is too high due to crude problems, atypical 1972-73 winter weather in Europe, or forthcoming protectionist policy initiatives on the part of European governments.

- Logistical or major company-market area constraints, which could act to impede the proper distribution of low-sulfur distillate to dirty-air areas and higher-sulfur distillate to cleaner-air areas, make sulfur standards a serious supply constraint.

- The demand estimates are too low, due to minimal relief of natural gas curtailment problems or undaunted auto-buying and auto-using habits.

C. ESTIMATING APPROACH

The forecasting problems outlined at the beginning of this section and the wide array of critical assumptions, supporting alternatively a more optimistic or more pessimistic view than ours, indicate the complex and uncertain circumstances surrounding short-to-moderate run fuels supply and demand estimates. Two choices exist in the face of these difficulties. One is to construct detailed structural or econometric estimates, which attempt to deal directly and explicitly with each uncertainty. A long series of detailed judgments or assumptions would be required, principally because the necessary data are not available. Another is to construct aggregate estimates, based on a few broad judgments, and to test their sensitivity. Our approach follows the latter course. In our opinion, the results probably are not inferior and the limitations are not disguised by elaborate technique. Where possible, we have attempted to make offsetting assumptions; for example, to hedge the possibility of high demand by holding stocks above absolutely minimum levels.

Given an estimate of domestic demand, the import requirement -- particularly from non-dedicated areas outside the Caribbean -- is driven mainly by four factors:

- U.S. and Caribbean refining capacity.
- The rate at which this capacity is utilized.
- The refining strategy followed domestically by the industry.
- Minimum acceptable product stock levels.

For each of these factors, our short run estimates are based on maximum probable conditions (optimistic refining rates and yields and nearly minimum stock requirements). For the moderate term our assumptions are more conservative, but remain more optimistic than refining and stock practices for the 1968-1971 period would suggest.

Our short and moderate term estimates assume a refining strategy aimed at maintaining near self-sufficiency domestically for gasoline. The exceptions are U. S. gasoline imports from Puerto Rico (which is U. S. -dedicated capacity) and minor gasoline imports from Canada and Italy (at levels typical of recent periods). This strategy forces the total import requirement onto distillate.

Equally important, our estimates represent only a two-product demand-supply balance. Ideally, gasoline and distillate supply estimates should stem from a comprehensive balance, which at least includes all products which trade with gasoline and distillate during refining. For example, our short run assumptions concerning the combined yield of gasoline and distillate reflect changes in octane levels and more severe refining of heavy products. Both increase the two-product yields at the expense of other products. Although this assumption reflects recent refining practice and, in our opinion, the most probable course of action of refiners in the short run, it disguises supply problems created in other refined products. For example, the supplies of napthas (for petrochemical use) and jet fuel already show signs of the adverse effect of our short run yield assumptions.

To deal with this problem explicitly, however, requires a demand-supply balance including all refined products and full consideration of the import possibilities for all these products. This full treatment is beyond the scope of this effort. For the short run, we estimate roughly that our import requirement (expressed as distillate) may be understated by up to 100 MB/D on this account; these extra imports, however, could also ultimately occur as gasoline, jet fuel, or petrochemical feedstocks.

Subject to these broad assumptions, our estimating approach is as follows:

Short Run (3Q, 1973 - 2Q, 1974)

- Demand is based primarily on extrapolation of experience during 1972 and the first half of 1973. Winter distillate demand is derived from weather-adjusting the 1972-73 heating season, and providing an incremental 70 MB/D increase for increased gas curtailment. Summer distillate demand is based on an extrapolation of the five-year trend for the same quarters. (See Appendix A.)

- Supply is based on:

  -- Current domestic and Caribbean refinery capacity, adjusted for minor capacity additions scheduled to come on-stream in early 1974 (See Appendix B and C).

  -- Maximum available Caribbean imports, equal to total output less local consumption.

  -- A domestic refining algorithm, based on almost total domestic gasoline self-sufficiency, and refining parameters indicated by 1973 practice (See Appendix D).

  -- A gasoline stockage policy which maintains 1972 stock levels, measured in terms of days supply.

  -- A distillate stockage policy which begins the third quarter at levels estimated to be best obtainable (in light of recent stocks, refinery rates and yield, and import rates).

Moderate-Term (1974-76)

- Demand is based primarily on extrapolation of 1968-1972 trends. In particular, distillate demand is based on weather-adjusted demand during the 1968-1972 period; also, annual increases due to natural gas curtailment are assumed to moderate during 1975.

- Supply is based on:
  - -- Domestic and Caribbean capacity, as augmented through 1976 by announced refinery construction projects.
  - -- Maximum available Caribbean distillate import capability, again equal to total output less local consumption.
  - -- A refining algorithm based on almost domestic gasoline self-sufficiency and operating rates and refining slates more representative of the 1968-1972 period than the unique 1973 year.
  - -- Stockage policy for both gasoline and distillate which achieves and maintains levels typical of 1971, measured in terms of days supply.

Our detailed demand and supply tables show the specific capacities, rates, yields and stock levels during each estimating period. In all cases, the estimates pertain only to PADs I-IV; PAD V is excluded for the following reasons:

- PAD V is basically self-sufficient, participating in only minor product transfers with PADs I-IV,
- Its refining practices and market demands are dissimilar to those in other PADs; and
- Preliminary tests indicate a general lack of any serious supply problem over the forecast period.

D. SHORT AND MODERATE TERM DEMAND-SUPPLY ESTIMATES

Table 1, on the following page, shows our demand estimates for gasoline and distillate. Also, Table 1 includes our stock level assumptions for the short run period as well as actual stock levels for the comparable quarters during the previous year.

Table II-1

Gasoline and Distillate Demand

PADs I-IV	Short Term						Moderate Term		
	1973				1974		1974	1975	1976
	1Q	2Q	3Q	4Q	1Q	2Q	Annual	Annual	Annual
Demand (MB/D)									
Gasoline									
Domestic Demand	5,425	5,925	6,069	5,838	5,657	6,275	6,118	6,436	6,771
Stock Change	-29	3	-16	154	220	-151	28	30	31
Net Shipments 1/	60	53	54	67	65	50	65	65	65
Net Demand	5,456	5,981	6,107	6,059	5,942	6,174	6,211	6,531	6,867
Distillate									
Domestic Demand	3,567	2,298	2,090	3,136	4,224	2,456	2,928	3,061	3,229
Stock Change	-441	302	593	32	-961	453	35	37	40
Net Shipments 1/	12	29	25	28	26	29	30	30	30
Net Demand	3,138	2,629	2,708	3,196	3,289	2,938	2,993	3,128	3,299
Stock Levels (MMB)									
Gasoline (end period)	184.3	184.6	183.1	197.3	217.1	203.4			
(1 year earlier)	(210.5)	(176.8)	(176.8)	(186.9)	(184.3)	(184.6)			
Distillate (end period)	101.5	129.0	183.6	186.5	100.0	141.3			
(1 year earlier)	(89.4)	(116.5)	(177.3)	(141.1)	(101.5)	(129.0)			

1/ Exports and shipments to PAD V

The "net demand" shown in Table 1 indicates the new supply required from domestic production and imports.[6/] The sources of this new supply are shown in Table 2, on the following page. Also, Table 2 shows the refining parameters assumed in calculating the makeup of the new supply.

1. CRITICAL SUPPLY ASSUMPTIONS

Our new supply estimates include the three categories of critical assumptions. The first category relates to refinery inputs which include the relationships between stream day capacity and operable calendar day capacity; crude runs, reruns and calendar day capacity; and NGL's and other hydrocarbons blended with gasoline yields on crude plus reruns. The second category of critical assumptions relates to the combined gasoline plus distillate yields on crude and reruns. The third relates to levels of stocks required to support a given level of total demand.

a. Refinery Inputs and Yields

With respect to refinery inputs and combined yields, our short run supply estimates primarily are based on operating experience during the first two quarters and half of the third quarter of 1973. These are not typical of past refinery practice; operating rates and combined yields were unusually high during this period. In contrast, NGL blending rates were lower than usual, reflecting a constrained supply of NGL's and higher than normal gasoline yields on crude.

Our moderate term assumptions about refinery operations do conform more nearly to past practice. The sensitivity of the estimates of supply available from

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6/ Net demand equals total consumption, net of stock changes.

Table II-2

Gasoline and Distillate Supply
(MB/D, Except as Noted)

	Short Term						Moderate Term		
	1973				1974		1974	1975	1976
PADs I-IV	1Q	2Q	3Q	4Q	1Q	2Q	Annual	Annual	Annual
Refinery Input									
Crude	10,203	10,640	10,754	10,685	10,644	10,875	10,858	11,455	12,132
Reruns	102	106	107	106	106	109	109	115	121
Gasoline									
Net Demand 1/	5,456	5,981	6,107	6,059	5,942	6,174	6,211	6,531	6,867
Yield: Crude & Reruns	4,591	5,265	5,376	5,287	5,160	5,437	5,336	5,614	5,906
NGL's & Other Hydrocarbons	791	631	646	687	697	652	800	842	886
Domestic Refinery Output	5,382	5,896	6,022	5,974	5,857	6,089	6,136	6,456	6,792
Import Requirement	74	85	85	85	85	85	75	75	75
Distillate									
Net Demand 1/	3,138	2,629	2,708	3,196	3,289	2,938	2,993	3,128	3,299
Yield on Crude & Reruns	2,607	2,429	2,498	2,633	2,689	2,528	2,451	2,601	2,794
Import Requirement	531	200	210	567	600	410	542	527	505
Caribbean Available	301			300	300		346	365	400
Eastern Hemisphere	230			267	300		196	162	105
Domestic Refining Parameters									
Stream Day Capacity (MB/SD)	11,818	11,818	11,818	11,818	12,289	12,289	12,289	12,964	13,732
Calender Day Capacity (MB/CD)	11,345	11,440	11,440	11,490	11,570	11,570	11,675	12,313	13,045
Operating Rate (%)	90.0	93.0	94.0	93.0	92.0	94.0	93.0	93.0	93.0
Blending Rate (%)	17.2	12.0	11.8	13.0	13.5	11.8	15.0	15.0	15.0
Gasoline Yield: Crude & Reruns (%)	44.6	49.5	49.5	49.0	48.0	49.5	48.7	48.5	48.1
Distillate Yield: Crude & Reruns (%)	25.3	22.8	23.0	24.3	25.0	23.0	22.3	22.5	22.9
COMBINED YIELD (%)	69.9	72.3	72.5	73.3	73.0	72.5	71.0	71.0	71.0

1/ From Table 1

domestic operations to different assumptions is tested.

b. Stock Levels

Our stock level assumptions, shown in Table 1, begin from our estimates of levels which will be attained at the end of the third quarter of 1973, in light of recently reported stocks and rates of imports. Thereafter our stock assumptions are tailored to place the bulk of the distillate stock drawdown in the first quarter of 1974. However, because stocks at the end of the third quarter of 1973 are forecast to be only slightly improved over the third quarter of 1972, our projected Eastern Hemisphere import requirement is level over the heating season. This is a moderately severe assumption, since imports from this area occurred only toward the end of the heating season last year. If Eastern Hemisphere imports are similarly delayed this season, end of fourth quarter distillate stocks could decline by about 25 MMB. At this point, distillate stocks would be slightly worse than they were when shortage incidents occurred last year.

Our gasoline stock assumptions slightly exceed last year's levels in comparable periods. In terms of days supply, however, gasoline stocks are slightly worse until the end of the first quarter of 1974. At that point, they are set about 10 MMB higher than last year in order to avoid the gasoline shortage situation which developed in mid-second quarter, 1973.

If heating season distillate imports fall short, because of either greater than forecast demand or a lack of adequate Eastern Hemisphere distillate imports, first quarter gasoline stock building could be traded for greater domestic distillate production. Over the first quarter, achieving gasoline stocks only equivalent to end of first quarter 1973 levels (adjusted for demand growth) would produce about 55 MB/D of extra domestic distillate output. Gasoline shortages similar to those encountered in the spring of 1973, however, undoubtedly would occur.

2. KEY SUPPLY-DEMAND CONCLUSIONS

Tables 1 and 2 reflect our estimates of gasoline and distillate demand and the course we expect will be followed to provide the necessary supply. In our opinion, these indicate a particularly tight supply situation extending through at least mid-1975, with only slight moderation through the end of 1976. Several major observations emerge from these estimates:

- Assuming a normal winter (in terms of degree-days and their distribution between the fourth and first quarters), distillate imports should average 580 MB/D over the 182-day, 1973-74 heating season. Up to 280 MB/D of these may be required from Eastern Hemisphere sources; this rate is 25 percent higher than that achieved during the 90-day first quarter of 1974.

- Unlike the 1972-73 heating season, the distillate import rate needs to accelerate at the outset of the fourth quarter and to be nearly level over the heating season, for three reasons:

    -- To hedge against an abnormally cold fourth quarter;

    -- To hedge against an abnormally cold overall heating season, principally by maintaining planned first quarter gasoline stockbuilding as a distillate reserve, if required; and

    -- To confine major stockdraw-downs to the first quarter -- in order to avoid panic measures in the midst of the heating season, especially ones which might over-compensate with respect to domestic distillate production and unnecessarily create a severe gasoline problem during the second quarter of 1974 (largely the case in 1973).

- The 1974 year, including the 1974-75 heating season, is the point of maximum stress on the supply system, for three reasons:

  -- Until 1975, the combined rate of gasoline and distillate demand growth continues to exceed the growth rate of domestic and Caribbean refining capacity;

  -- As a result, 1974 distillate imports must increase at least 40 percent over 1973 levels (assuming fourth quarter 1973 imports nearly equal first-quarter 1974 levels); despite an anticipated 15 percent increase in Caribbean-available distillate, Eastern Hemisphere imports must increase by about 60 percent in 1974 over 1973; and

  -- Equally significant, 1974 average annual distillate imports (540 MB/D) are only slightly lower than those required during the first quarter of 1974 (600 MB/D); if there is the usual, large off-season sag in imports, fourth quarter 1974 import rates reach very high levels (a 50 percent drop, to 300 MB/D in the second and third quarter, would produce a 960 MB/D requirement in the fourth quarter). This could create a summer problem of storage capacity or, conversely, a fourth quarter problem of tanker and port capacity.

- Beginning in 1975 and continuing through 1976, domestic refinery capacity should expand annually at about a 1 percent greater rate than gasoline and distillate demand. Combined with Caribbean expansion, Eastern Hemisphere distillate import requirements will decline. By end 1976, however, domestic and Caribbean expansion will still require Eastern Hemisphere imports 23 percent greater than 1973 levels (approximately 105 MB/D annually).

Four things are especially important to weigh with respect to these observations:

- Although domestic refinery construction announcements -- apparently in response to changes in the U.S. import program -- are encouraging, firm expansion makes only a minor improvement in the gasoline and distillate supply outlook through 1976.

- It is too early to draw conclusions concerning 1977, because construction leadtimes do not require firm commitments yet. Based on announced construction scheduled to come onstream in 1977, substantial addition projects still are required to even maintain 1976 import levels.
- Improvement in the import situation, as forecast, depends heavily on domestic construction. Seventy percent of the incremental distillate supply through 1976 should stem from domestic expansion and about 25 percent from Caribbean.
- At least through 1976, and possibly beyond, a rather permanent requirement for other than Caribbean distillate exists; to assure reasonable reliability of this supply, specific moderate term commitments may be required.

E. SENSITIVITY OF DEMAND-SUPPLY ESTIMATES

At the outset of this section, the problems of forecasting gasoline and distillate demand and supply and the resulting, speculative character of current estimates were described. The sensitivity of our baseline estimates to a variety of critical estimating assumptions is presented here.

1. OVERVIEW OF THE SENSITIVITY ANALYSIS

Our baseline demand-supply estimates derive from a coordinated set of estimating assumptions. Testing the sensitivity of the estimates to these assumptions is not straightforward, for two reasons:

- The refining process can be adjusted to compensate for a change in a single refining parameter such as operating rate. Over a reasonable range, the multi-product nature of refining provides many combinations of individual parameters which can produce the same amount of gasoline and distillate output. These parameters, however, are not completely independent, for three reasons:
    - Technical limits are imposed by the existing refinery stock of crude distillation and downstream converting equipment;

- -- Market limits are imposed by the demand for the full range of refined products and the various supply options for each (including domestic production from crude, product imports, and in some cases latitude to substitute non-petroleum inputs in petroleum consuming industrial processes); and

- -- Logistical limits imposed by physical transportation constraints, transportation costs, and the general practice of designing and locating refineries primarily to meet the unique market demands existing generally within about a 300-mile radius of a refinery.

Fortunately, the supply issue here involves levels of distillate and gasoline imports which can be varied widely probably without violating these technical and logistical constraints. The market limits, however, are more serious and are dealt with only indirectly in our two-product analysis.

- Changing the assumptions underlying our baseline forecast affects the estimates in varying magnitudes and at different points in time. These effects fall into three categories:

  - -- Cumulative effects which become most significant only by 1976 (e.g., demand growth rates and understating the announced capacity of new construction);

  - -- One-time effects which primarily are significant only in the short-run (e.g., gasoline and distillate stock levels); and

  - -- Proportional effects which are significant over all time periods but in different amounts over time (e.g., weather, operating rates, yields, gasoline imports and NGL blending).

Our approach is to divide the sensitivity analysis along the lines of our short run and moderate term estimates. The estimating assumptions are tested only where they are critical to either time frame.

2. REFINING ALGORITHM

A useful overview of the sensitivity analysis is indicated by inspection of the supply algorithm employed in making our estimates (Appendix D to this section explains this algorithm in detail). The algorithm is shown below:

$$\begin{matrix}\text{Eastern Hemisphere}\\\text{Distillate Imports}\end{matrix} = \begin{bmatrix}\text{Distillate}\\\text{Demand}\end{bmatrix} + \begin{bmatrix}\text{Gasoline}\\\text{Demand}\end{bmatrix} - \begin{bmatrix}\text{Domestic}\\\text{Output}\end{bmatrix} - \begin{bmatrix}\text{Caribbean}\\\text{Distillate Imports}\end{bmatrix}$$

Or $$I_{de} = D_d + \left[\frac{D_g - I_g}{k_3}\right] - \left[C_s \cdot R \cdot k_1 \cdot k_2 \cdot k_4\right] - I_{dc}$$

Where $\left(\frac{D_g - I_g}{k_3}\right)$: Represents net gasoline output from crude with NGL's blended at rate k_3 ($k_3 \leq 1.0$)

And $\left(C_s \cdot R \cdot k_1 \cdot k_2 \cdot k_4\right)$: Represents refinery operations with stream day capacity C_s; operable calendar day capacity ($C_s \cdot k_1$), operating rate R, reruns k_2, and combined gasoline plus distillate yield k_4

By inspection (or by partial differentiation) several things are apparent:

- Gasoline and distillate demand (D_g, D_d) and imports (I_g, I_{dc}) trade one-for-one with Eastern Hemisphere imports;
- The NGL blending rate trades less than one-for-one ($1/k_3$); in fact NGL's trade one-for-one with Eastern Hemisphere ports volume wise, but only over a narrow range equal to about ∓100 MB/D.
- Refinery operations ($C_s \cdot R \cdot k_1 \cdot k_2 \cdot k_4$) trade linerarly with Eastern Hemisphere imports at negative rates which vary with the particular parameter treated as a variable; the highest rate occurs when the combined yields (k_4) is the variable because it is the smallest numerical value of the term consisting of ($R \cdot k_1 \cdot k_2 \cdot k_4$).

The greatest interdependence between these variables occurs with respect to refining operations term ($R \cdot k_1 \cdot k_2 \cdot k_4$), principally due to the market limitations discussed previously. For example, in viewing our sensitivity estimates, it is not correct to assume that the combined yield can be increased dramatically to compensate for a lower operating rate; the resulting gasoline and distillate output increase will occur at the expense of other refined products. Implicit in such an assumption is either that other product imports can make up any resulting domestic supply deficit or a shortage situation with respect to these other products is preferable.

3. SENSITIVITY OF THE SHORT RUN ESTIMATES

Demand, operating rate and combined yield, and stock levels represent the most critical assumptions underlying our short run estimates. Gasoline imports also have an effect; in our opinion, the range of estimating error with respect to gasoline imports is relatively low.

a. Demand

Our baseline estimates indicate an Eastern Hemisphere distillate import requirement averaging approximately 280 MB/D over the 1973-74 heating season (in addition to 300 MB/D required from the Caribbean). This is based on a normal winter and represents a 7.6 percent growth in weather-adjusted distillate demand compared to the 1972-73 heating season. The response of Eastern Hemisphere imports to different demand growth assumptions is shown below:

Distillate Demand vs Eastern Hemisphere Imports

"Normal" Distillate Demand (D_d)	Imports (I_{de})
+2%	340 MB/D
+1%	310
Baseline	280
-1%	250
-2%	220

By way of comparison, a one-in-five colder or warmer heating season could increase or decrease our normal-winter estimate by ∓ 120 MB/D.[7]

b. Operating Rate and Combined Yield

Previously, we indicated that the effects of operating rate and the combined yields of gasoline plus distillate should be considered jointly. Exhibit II-1, on the following page, shows the effect of operating rate and yields on the Eastern Hemisphere distillate import requirement. Also, it indicates our assumptions as well as the amount required if rates and yields this winter were identical to the 1971-72 and 1972-73 winters. The particular severity of the combined yield assumption is apparent; the import requirement is quite sensitive to both assumptions, as indicated below:

Rate x Yield vs Eastern Hemisphere Imports

	Imports (I_{de}, MB/D)			
	% Yield (k_4)			
% Operating Rate (R)	71	72	73.3	74
90.5	680	570	440	370
91.5	600	490	360	290
92.5	520	410	280	210
93.5	440	330	200	130

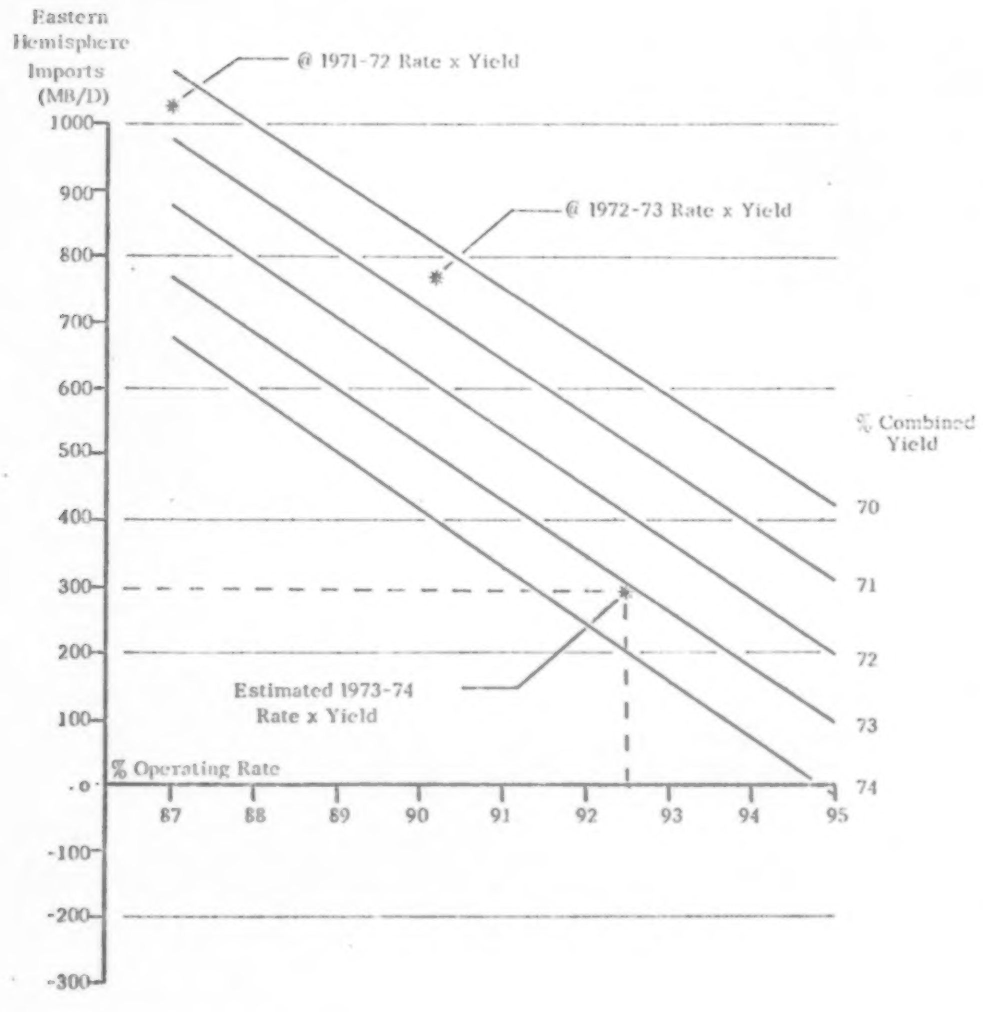
c. Stock Levels

Table 1, on page 70, indicated the gasoline and distillate stock levels underlying our baseline estimates. Both end first-quarter distillate stocks and end second-quarter gasoline stocks may be above absolute minimums by ten million barrels.

7/ Department of the Interior, "The Distillate Fuel Oil Situation, Winter 1973-74," 1973.

EXHIBIT II-1

Effect of Operating Rate and Yields on Eastern Hemisphere Distillate Imports
Winter: 1973-1974



(Negative imports indicate less than full Caribbean available distillates are required)

The effect of more severe stock assumptions is shown below:

Stock Levels vs Eastern Hemisphere Imports

Stock Levels	Imports (I_{de})
Baseline	280 MB/D
- 10 MMB (Dist)	225
- 20 MMB (Dist + Gas)	170

d. Conclusions

In our opinion, the most plausible range of the Eastern Hemisphere distillate import requirement is defined by two opposite scenarios.

- Case I: A colder than normal winter, an operating rate of 91.5 percent and a combined yield of 72 percent, and a maximum stock drawdown.
- Case II: A warmer than normal winter, an operating rate of 93.5 percent and a combined yield of 73.3 percent, and above minimum stocks.

The range of Eastern Hemisphere imports required under these cases, and the base care, are shown below:

Range of Eastern Hemisphere Imports

	Case I	Baseline	Case II
Imports (I_{de})	480	280	80
Components			
• Weather*/	+120		-120
• Operating Rate	+ 80		- 80
• Combined Yield	+110		-
• Stock Change	-110		-

---

*/ Department of the Interior, "The Distillate Fuel Oil Situation, Winter 1973-74," 1973. Represent variation with a one-on-five colder than normal winter.

4. SENSITIVITY OF THE MODERATE TERM ESTIMATES

Demand, stream day refinery capacity, operating rates and yields and NGL blending rates represent the most critical assumptions underlying our moderate term estimates. Our baseline forecast indicates that 1974 is the point of maximum stress on the gasoline and distillate supply system. Changing two of the above assumptions, demand and refinery capacity, can shift this stress point backward or forward in time. This occurs because of the compounding effect overtime of alternative demand and capacity growth rate assumptions, since the difference between these two growth rates determines import requirements.

In contrast, the effects of operating rate, combined yield, and NGL blending rate are proportional during each of the years during the 1974-1976 period. Our analysis shows their effects only during 1974, the point of maximum stress according to our baseline estimates. The incremental effects in other years are nearly identical.

a. Demand

Our moderate term baseline estimates indicate an average annual Eastern Hemisphere import requirement which peaks in 1974 (at about 200 MB/D) and then declines by 1976 to approximately 105 MB/D. The table below indicates the impact of a higher and low cumulative, year-to-year demand growth rates on this import requirement.

Demand Growth vs Eastern Hemisphere Imports

Cumulative Demand $\left(D_g + D_d\right)$	Imports (I_{de}, MB/D)		
	1974	1975	1976
+0.5%	240	250	220
Baseline	200	160	105
-0.5%	160	80	(40*)

---

* Indicates less than maximum Caribbean available imports are required.

As indicated above, a small cumulative demand estimating error has its principal affect beginning in 1975. A one-half percent higher rate maintains a high level of stress through 1976. The same, lower rate decreases the amount of stress in 1974. More important, it reduces the duration of a continuing requirement for Eastern Hemisphere imports.

In practice, however, a lower demand growth rate probably would be translated into a combination of moderated operating rates and combined yields if a sustained, reliable European import commitment can be obtained. For example, a permanent Eastern Hemisphere commitment of 100 MB/D and a one-half percent lower demand growth rate could be translated into a 71.0 percent combined yield and a 91.5 percent operating rate (compared to 93.0 percent assumed in the baseline estimates).

b. Refining Capacity

Our moderate term estimates are based on "nominal" stream day capacity ratings of firm construction projects. It is not unusual for new refinery projects to operate at more than initial rated capacity, after initial shakedown. For example, some projects have been re-rated at a 20 percent higher capacity. In addition, refinery debottlenecking has tended to increase capacity annually by about 1 percent above forecast levels.

The table, below, shows the effect on Eastern Hemisphere imports of various levels of understatement of incremental refinery capacity:

Refinery Capacity vs Eastern Hemisphere Imports

Capacity (C_s)	Imports (I_{de}, MB/D) 1974	1975	1976
Baseline	200	160	105
+ 5.0%	180	130	30
+10.0%	170	90	(30*)

---

* Indicates less than maximum Caribbean Imports are required.

Similar to demand, the main effect of greater capacity growth occurs in 1976. Also, given a permanent Eastern Hemisphere supply commitment, greater capacity probably would be translated into a less severe operating rate.

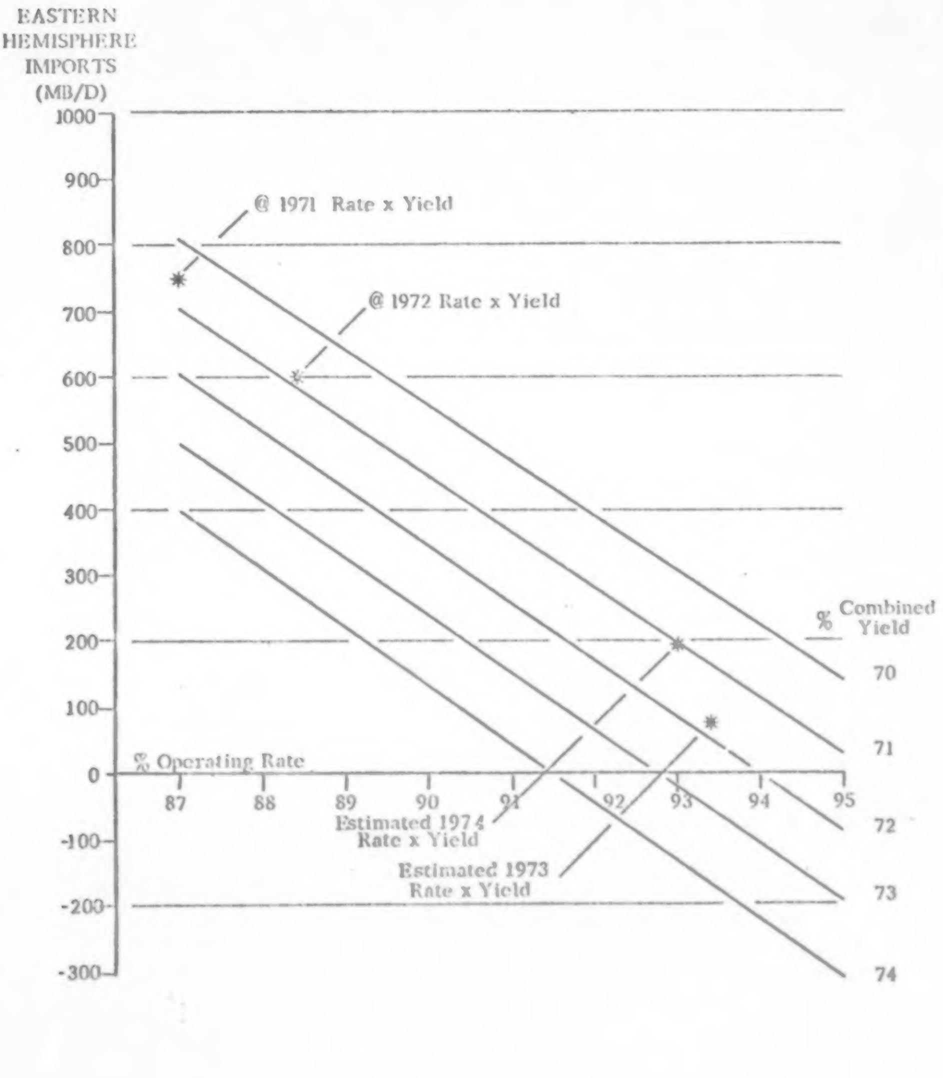
c. Operating Rate and Combined Yield

Exhibit 2, on the following page, shows the effect of operating rate and combined yield on the import requirement during 1974 as well as the amount required if various historical rates and yields occurred. As indicated by the exhibit, our moderate term assumptions are slightly less optimistic than refinery experience during 1973 could suggest. Although our assumptions appear severe in comparison to 1971 and 1972, the operating rate assumption principally is responsible for the difference. In our opinion, these previous operating rates represent excess capacity and crude constraints rather than technical refinery constraints.

EXHIBIT II-2

Effect of Operating Rates and Yields on Eastern Hemisphere Distillate Imports

YEAR: 1974



The table, below, shows the effect on 1974 Eastern Hemisphere imports of a more plausible range of rates and yields:

Rate x Yield vs Eastern Hemisphere Imports: 1974

	Imports (I_{de}, MB/D)			
	% Yield (k_4)			
% Operating Rate (R)	70	71	72	73
94	220	120	0	(110)*
93	310	200	80	(10)*
92	390	280	180	60
91	470	370	260	150

---

* Indicates that less the maximum available Caribbean imports are required.

It is important to note that to maintain Eastern Hemisphere imports during 1974 at expected 1973 levels (80 MB/D) requires a combined yield of 72 percent, even at a high operating rate of 93 percent. Alternatively, even a 1 percent slip in operating rate or combined yield requires approximately a 1 percent compensation in the other parameter. In our opinion, a sustained combined yield of more than 71 percent at operating rates of less than 93 percent would cause shortages in other products. Conversely, we consider an average annual operating rate of 94 percent extremely difficult to attain.

d. NGL Blending Rates

NGL blending rates are expected to average 13.25 percent during 1973; this compares to 14.1 percent during 1972 and 13.8 percent during 1971. The table, below, indicates the effect of a range of NGL blending rates on Eastern Hemisphere imports.

NGL Blending Rate vs Eastern Hemisphere Imports

% Blending Rate	Imports (I_{de})
13	290 MB/D
14	240
15 (Base)	200
16	150
17	100

As indicated, above, NGL blending is (subject to technical limits) a compensating parameter for imports or for changes in operating rate and combined yield. It is, however, comparately less effective than operating rates and yields. A one percent change in NGL blending rate changes imports by 47 MB/D while similar percentage, variations in operating rates and yields change imports by 84 MB/D and 110 MB/D, respectively.

e. Conclusions

Previously, we concluded that 1974 represents the year Eastern Hemisphere distillate import requirements will peak. Given "normal" winter weather, our baseline estimate indicates that Eastern Hemisphere distillate must average 200 MB/D over the 1974 year. The moderate term sensitivity analyses show that the 1974 level could deviate substantially from 200 MB/D; these imports either could fall off rapidly or remain relatively constant in subsequent years.

With respect to 1974, the most plausible range of the Eastern Hemisphere distillate import requirement is defined by two opposite scenarios:

- Case I: Higher than forecast demand growth; back-to-back colder than normal winters (1973-74 and 1974-75); an average annual operating rate of 92 percent and combined yield of 71 percent; and a 14 percent NGL blending rate.

- Case II: Lower than forecast demand growth; back-to-back warmer than normal winters; a 10 percent understatement of new refinery capacity; an average annual operating rate of 93 percent and combined yield of 72 percent; and a 15 percent NGL blending rate.

The range of Eastern Hemisphere imports required under these cases, and the base case, are shown below. The contribution of each assumption to the variation from the base case is also shown:

Range of 1974 Eastern Hemisphere Imports

	Case I	Baseline	Case II
Imports (I_{de}) MB/D	430	200	(40)*
Components			
• Demand Growth	+40		-40
• Weather**	+60		-60
• Capacity	--		-30
• Operating Rate	+80		--
• Combined Yield	--		-110
• NGL Blending	+50		--

---

* Indicates less than full Caribbean available distillates are required.

** Department of the Interior, "The Distillate Fuel Oil Situation, Winter 1973-74," 1973. The one-in-five weather variation is half as large as indicated for the 1973-74 winter because, on a MB/D-basis, the effect is averaged over 365 rather than 182 days.

As indicated above, small individual changes in our demand and supply assumptions can swing the average annual Eastern Hemisphere import requirement substantially during 1974. Of course, the two scenarios chosen used assume that various demand and supply components simultaneously might become more or less adverse. Our combinations of circumstances are based on the following judgments:

- Our baseline NGL blending rate assumption is optimistic (15 percent compared to 13 percent expected in 1973); we selected 14 percent for the high import case (Case I) because a lower operating (and resulting lower output of gasoline on crude plus reruns) combined with a constant volume of NGL inputs would cause the 1973 "computed" blending rate to increase without any real change in the quantity of NGL's blended.

- Jointly, our operating rate and combined yield assumptions are moderately optimistic. Based on other products' demand levels and their supply options, the 1973 combined yield might increase, given our baseline operating rate, (Case II) or might hold constant at a lower operating rate (Case I). Because we believe that any slack in the other product supply situation already has been taken up due to the high combined yield experienced in 1973, it is unlikely that 1974 combined yields could be increased if the operating rate were to decline.

Subject to these judgments, it is important to note the large influence of demand uncertainties on 1974 imports. The "normal" demand growth variation is based on a one-half percent error in estimating the 1973 to 1974 demand growth rate; this represents a small error, equal to 0.4 percent of our total baseline demand estimate for the 1974 year. Consequently, we believe that the Case I scenario may be conservative, considering the likelihood that our estimating error for "normal" demand will exceed the range given above. The weather-related demand variation is based on two "one-in-five" abnormally cold winter quarters occurring in a row (1Q and 4Q, 1974). Given the probability of such an occurrence, both scenarios may overstate the likely effects of abnormal winter weather on imports.

With respect to the trend of Eastern Hemisphere imports after 1974, the relative importance of the individual baseline estimating assumptions shifts. The proportional variables -- weather, operating rate, combined yield and NGL blending rates -- have approximately the same-sized impact on imports in later years. The cumulative variables -- "normal" demand and stream day capacity growth rates -- vary the reference import level to which the proportional variation might apply. As a result, the plausible range of Eastern Hemisphere imports widens over time. The table that follows shows the effect of applying these same scenarios in 1976.

Range of 1976 Eastern Hemisphere Imports

	Case I	Baseline	Case II
Imports $\left(I_{dc}\right)$ MB/D	430	100	<330>*
Components			
• Demand Growth	+130		-130
• Weather	+ 60		- 60
• Capacity	--		-120
• Operating Rate	+ 90		--
• Combined Yield	--		-120
• NGL Blending	+ 50		--

---

* Indicates less than full Caribbean available imports are required.

In contrast to 1974, the demand and refinery capacity variation account for 65 percent of the variation difference between the Case I and Case II import requirement. Also, because the assumptions underlying our baseline estimates lead to a forecast downtrend in imports through 1976, the worst import scenario (Case I) indicates the same import requirement as the 1974 worst case; the best import scenario (Case II) receives the major benefit of less rapid "normal" demand growth and more rapid expansion of refining capacity.

F. COMPARISON WITH DOI ESTIMATES

The preceding part of this section analyzed the effects on our baseline forecasts of changing various estimating assumptions. Here, we compare our forecasts with those made by the U. S. Department of the Interior (DOI) and test the sensitivity of the DOI estimates to different operating rate and stock level assumptions.

1. COMPARISON OF DOI AND ICF BASELINE FORECASTS

Table 3, on the following page, compares the DOI and ICF baseline forecasts for PADs I-IV. The comparison covers the three consecutive quarters beginning with the fourth quarter of 1973. The DOI forecast through the third quarter of 1974; since our detailed short-term forecast ends at mid-year, a third quarter comparison is not included.

The detail of the DOI forecast shown on Table 3 was derived from discussions with the DOI Office of Oil and Gas; we believe it represents their forecast with reasonable accuracy, although minor adjustments were made to exactly balance their demand and supply estimates and to align them with our format. Also, to minimize "timing" differences between the two estimates (e.g., the distribution of heating season distillate imports between the fourth quarter and first quarter), the comparison averages the two winter quarters of 1973-74 as well as the entire three quarter period. The results of the comparison are summarized below:

TABLE II-3

ICF vs DOI Distillate and Gasoline Forecasts

(MB/D, Except as Noted)

PAD'S I-V	WINTER: 1973-74		2Q. 1974		Period Average	
	ICF	DOI	ICF	DOI	ICF	DOI
Demand:						
Gasoline						
Domestic Demand	5,748	5,722	6,275	6,240	5,923	5,895
Stock Change	187	255	- 151	-296	74	71
Net Shipments	66	61	50	50	61	57
Net Demand	6,001	6,038	6,174	5,994	6,058	6,023
Distillate						
Domestic Demand	3,680	3,712	2,456	2,185	3,272	3,203
Stock Change	-465	-541	453	423	-159	-220
Net Shipments	27	20	29	12	28	17
Net Demand	3,242	3,191	2,938	2,620	3,141	3,000
Stock Levels: (MMB)						
Gasoline (end period)	217.6	224.0	203.4	197.1		
Distillate (end period)	100.0	89.3	141.3	127.8		
Supply						
Refinery Input						
Crude	10,664	10,508	10,875	10,438	10,735	10,484
Reruns	106	124	109	- 15	107	78
Gasoline Outputs						
Yield: Crude & Reruns	5,224	5,073	5,437	5,119	5,295	5,088
NGL's & O.H. Blended	692	840	652	725	679	802
Refinery Output	5,916	5,913	6,089	5,844	5,973	5,890
Imports	85	125	85	150	85	133
New Supply	6,001	6,038	6,174	5,994	6,058	6,023
Distillate Outputs						
Yield: Crude & Reruns*	2,661	2,535	2,528	2,272	2,617	2,447
Imports	581	656	410	348	524	553
New Supply	3,242	3,191	2,938	2,620	3,141	3,000
Refining Parameters	11,530	11,484	11,570	11,624	11,543	11,497
Calendar Day Capacity						
% Operating Rate	92.5	91.5	94.0	89.8	93.0	91.2
% Gasoline Yield: Crude & Reruns	48.5	47.7	49.5	49.0	48.8	48.2
% Distillate Yield: Crude & Reruns	24.7	23.8	23.0	21.8	24.1	23.1
(% Gasoline & Distillate Yields)	(73.2)	(71.5)	(72.5)	(70.8)	(73.0)	(71.3)

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Summary: ICF vs DOI Short-Term Forecasts
(MB/D)

	Winter: 1973-74		Nine Months	
PAD'S I-IV	ICF	DOI	ICF	DOI
Domestic Demand (total)				
Gasoline	5,748	5,722	5,923	5,895
Distillate	3,680	3,712	3,272	3,203
	9,428	9,434	9,195	9,098
Refinery Output				
Gasoline	5,916	5,913	5,973	5,890
Distillate	2,661	2,535	2,617	2,447
	8,577	8,448	8,590	8,337
Imports				
Gasoline	85	125	85	133
Distillate	581	656	524	553
	676	781	609	686

For the winter period, the two estimates generally agree; the key points of difference -- total imports and the import mix between gasoline and distillate -- stem mainly from DOI's lower operating rate and distillate yield assumptions. The estimates for the nine month period begin to diverge, primarily because of different demand and refining expectations and varying degrees of distillate stock building during the second quarter of 1974. Actually, however, the forecasts disagree significantly in detail. A comparison of the areas of difference is shown below:

Detailed Variance of ICF vs DOI Forecasts
(MB/D)

	Winter	Nine Months
Lower Net Demand*	- 14	- 176
Higher/Lower(-) Total Demand	6	- 97
Greater Stock Changes	- 8	- 64
Lower Net Shipments	- 12	- 15
Lower Refinery Output	129	254
Lower Capacity	63	21
Higher/Lower (-) Reruns	- 18	- 29
Lower Rate x Yield	232	327
Higher NGL Blending	-148	- 123
Higher Imports	115	78
Gasoline	40	48
Distillate	75	29

---

* Means DOI net demand estimate is lower than ICF; signed values indicate that the assumption makes DOI's import requirement larger (+) or smaller (-) than ICF's.

As indicated above, the DOI winter forecast anticipates offsetting a decline in domestic refinery operating rates mainly with higher NGL blending (to maintain total gasoline output), and higher imports of both gasoline and distillate. The larger net demand and refining differences shown for the nine-month period are caused by significantly different expectations for the second quarter of 1974. For the nine-months (and particularly for the second quarter), DOI anticipates lower total demand -- principally for distillate -- and an additional decline in refinery operating rates which it offsets with a continuation of higher NGL-blending and gasoline import rates.

It is particularly import to note the narrowing of the difference, shown above, between the DOI and ICF distillate import requirement over the total nine month period. This is caused by DOI's lower distillate stock level assumptions for the end of both the first and second quarters of 1974; these stock level differences reduce

DOI's distillate import requirement by 77 MB/D during the winter and by an average of 62 MB/D over the nine month comparison period.

2. SENSITIVITY OF DOI FORECAST

Previously, we indicated the sensitivity of our short-term baseline estimates to a various assumption and concluded that winter weather, operating rate, combined yield and stock levels are the critical short-term variables. The size of the impact of each of these variables on the DOI forecast is nearly identical. Because the DOI baseline assumptions differ from ours, the two opposing winter scenarios to those applied to our baseline estimates are modified as follows:

Case I:	A colder than normal winter, an operating rate of 90.5 percent and a combined yield of 71.5 percent, and a maximum gasoline stock drawdown. Because of DOI's low, baseline operating rate, this case does not increase the combined yield to offset a further rate decline; also, distillate stocks already are minimized in the DOI base-case.
Case II:	A warmer than normal winter, an operating rate of 92.5 percent and a combined yield of 72.0 percent, and above minimum stocks. This case brings a slight combined yield increase to make rate and yield identical to our Case I; also, distillate stocks are increased to the levels applied to our base-case.

The range of total distillate imports required under these two alternative scenarios for the DOI forecast are shown below and compared to our range of estimates.

Comparison of the ICF and DOI Range of Winter Imports

	Case I	(MB/D) Baseline	Case II
Distillate Imports (ICF)*	770	570	370
Distillate Imports (DOI)	840	660	490
• Weather	+120		-120
• Operating Rate	+ 80		- 80
• Combined Yield	-		- 50
• Stocks	- 20		+ 20

---

* Caribbean imports are added back to the previously indicated ICF Eastern Hemisphere requirement to put both estimates on a comparable basis.

Note that due to the construction of the DOI baseline forecast, Case I differs from the comparable ICF case the least and Case II differs the most. The basis for these differences is explored below.

In the DOI baseline forecast, the winter import requirement is affected by an estimated decline in the domestic refinery operating rate extending through the end of the third quarter of 1974 (where the DOI forecast terminates). In order to determine the effect of maintaining DOI's fourth quarter, 1973 operating rate throughout their forecast period, we prepared Table 4, on the following page.

In Table 4, the DOI forecast is modified in two steps. The first (D-1) maintains a 91.9 percent operating rate, and the DOI's forecast gasoline stockage policy. The second (D-2) alters the gasoline stockage policy, to shift the maximum effect of continued higher operating rates backward in time in order to reduce distillate imports during the 1973-74 winter (in Table 4, constant values are indicated by a dash to highlight the key areas of change). The results of these modifications are

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TABLE II-4

DOI Baseline and Modified Forecasts
(MB/D, Except as Noted)

PAD'S I-IV	WINTER, 1973-74			2Q, 1974			3Q, 1974		
	DOI	D-1	D-2	DOI	D-1	D-2	DOI	D-1	D-2
Demand									
Gasoline									
Domestic Demand	5,722	*	*	6,240	-	-	6,233	-	-
Stock Change	255	*	67	-296	-	-135	-304	-	-92
Net Shipments	61	*	*	50	-	-	50	-	-
Net Demand	6,038	*	5,850	5,994	-	6,155	5,979	-	6,191
Distillate									
Domestic Demand	3,712	*	*	2,185	-	-	1,912	-	-
Stock Change	-541	*	*	423	-	-	669	-	-
Net Shipments	20	*	*	12	-	-	20	-	-
Net Demand	3,191	*	*	2,620	-	-	2,601	-	-
Stock Levels (MMB)									
Gasoline (end period)	224.0	*	189.8	197.1	-	177.5	169.1	-	-
Distillate (end period)	89.3	*	*	127.8	-	-	189.3	-	-
Supply									
Refinery Input									
Crude	10,508	10,556	10,556	10,438	10,682	10,682	10,475	10,770	10,770
Reruns	124	*	*	- 15	-	-	160	-	-
Gasoline									
Yield Crude & Reruns	5,073	*	4,885	5,119	-	5,280	5,209	-	5,421
NGL's & O.H. Blended	840	*	*	725	-	-	620	-	-
Refinery Output	5,913	*	5,725	5,844	-	6,005	5,829	-	6,041
Imports	125	*	*	150	-	-	150	-	-
New Supply	6,038	*	5,850	5,994	-	6,155	5,979	-	6,191
Distillate									
Yield Crude & Reruns	2,535	2,571	2,761	2,272	2,432	-	2,318	2,525	-
Imports	656	620	430	348	188	-	283	76	-
New Supply	3,191	*	*	2,620	-	-	2,601	-	-
Refining Parameters									
% Operating Rate	91.5	91.9	91.9	89.8	91.9	91.9	89.4	91.9	91.9
% Gasoline Yield	47.7	47.5	45.7	49.0	48.0	49.5	49.0	47.7	49.6
% Distillate Yield	23.8	24.0	25.8	21.8	22.8	21.3	21.8	23.1	21.1
(% Combined Yield)	(71.5)	*	*	(70.8)	-	-	(70.8)	-	-

summarized, below:

Modified DOI Baseline Forecast

PAD's I-IV	Winter	2Q, 1974	3Q, 1974
Operating Rate (%)			
DOI - Base	91.5	89.8	89.4
D-1	91.9	91.9	91.9
D-2	-- same as D-1 --		
Gasoline Stocks (MMB)			
DOI-Base	224.0	197.1	169.1
D-1	-.- same as DOI-Base --		
D-2	189.8	177.5	169.1
(levels last year)	183.4	176.8	176.8
Distillate Imports (MB/D)			
DOI-Base	656	348	283
D-1	620	188	76
D-2	430	--same as DOI-Base --	

The summary above, indicates three things:

- An improved operating rate in the post-winter quarters reduces the winter distillate imports only slightly;

- A "tighter" gasoline stockage policy, coupled to an improved operating rate, could reduce winter distillate imports significantly (by 230 MB/D, or about 35 percent of forecast) while attaining the same end of third-quarter 1974 gasoline stock level.

- End of third-quarter 1974 gasoline stocks for the DOI forecast appear severely low. This level of gasoline stocks may, however, reflect a "best possible" assumption, given the large drop in summer distillate imports projected by DOI and the resulting need to trim domestic gasoline output next summer to build distillate stocks.

3. CONCLUSIONS

For the period over which a comparison can be made, our estimates and the DOI estimates are not different in a "statistical" sense, considering the uncertainties underlying both forecasts. The small overall differences occur, however despite large differences in the details of the estimates. These differences cancel in aggregate, probably because of certain tendencies which may bias both estimates. Because of this result, it may be useful to identify where biases may exist in the DOI forecast as well as in our own forecast.

In our opinion, the high-side bias toward overestimate import requirements potentially enters the DOI estimates at two places:

- The declining operating rate, predicated upon tight crude supplies; and
- The low combined yield, predicated upon what should happen to protect other product supply positions.

To moderate the size of the import requirement resulting from these assumptions the DOI estimates containing offsetting assumptions in two other areas·

- NGL-blending rate increases, predicated upon an improving supply picture; and
- Extremely low stocks of distillate at end of the first quarter of 1974 and of gasoline at end of the third quarter of 1974.

Unfortunately, the DOI estimat es do not continue through 1976, because a day of reckoning, which is hidden in their short run estimating assumptions, may exist at the point in time when gasoline stocks are rebuilt. Of course, its seriousness would depend on the trend of operating rates DOI would project beyond the end of their forecast period.

Our estimates, generally, are less pessimistic than DOI's due to our judgment that -- absent an intentional, retaliatory curtailment of Mid-East and African crude exports -- adequate crude will be available, for two reasons:

- Crude liftings in these key import areas are increasing at a rate sufficient to meet growing U. S. import needs; and
- The U. S. crude logistic system is adjusting to adequately allocate sweeter crudes to metallurgically-limited mid-continent refiners (by reversing pipeline flows) and more confined, more sour imported crudes to coastal refineries with proper metallurgy.

Beyond this key area, our estimates may introduce other bias. High-side bias may enter our estimates in two areas:

- Eastern Hemisphere imports may be overstated due to additional Western Hemisphere imports available from South America (DOI estimates anticipate greater western imports due to increased South American flows); and
- Stocks may be slightly higher than absolutely required.

The principal low-side bias may involve the high combined yield assumptions underlying our estimates. As pointed out previously, we believe that our yields represent what will happen. But, our two-product analysis disguises potential supply problems with respect to other products.

G. VUNERABILITY TO CRUDE IMPORT INTERRUPTIONS

Above, we indicated that DOI may be overly pessimistic in their forecast about crude availability. Short of a catastrophic interruption of crude imports, we believe adequate crude imports will be available to allow domestic refineries to operate at whatever rate they are technically capable of maintaining. This conclusion is based on three observations:

- Liftings of Eastern Hemisphere crude have been increasing at a brisk rate. Although a few countries are reaching their immediate production limits, a key U S supplying country -- Saudi Arabia -- appears to be capable of expanding at a sufficiently rapid rate to supply increasing world demands.

- Internationally, the tanker supply outlook is adequate to provide a higher rate of crude movements from the Persian Gulf to the U. S.

- The major domestic logistical restructuring necessary to deal with increased crude imports is nearly complete; we do not foresee another period of logistical disorder in the near future capable of causing shortages.

Consequently, we believe one of either two things will happen Adequate crude will be available, at which point domestic refinery capacity and unpredictable demand events (e. g., adverse weather) will couple with product import constraints to cause shortages. Alternatively, a major crude supply interruption might occur do to, perhaps, hostilities in the Middle East.

1. IMPACT OF A MIDDLE EAST CRUDE SUPPLY INTERRUPTION

Table II-5, on the following page, provides a rough estimate of the impact of an Arab crude interruption on the U S. gasoline and distillate import requirement. It covers a four-quarter period, hypothetically beginning at the outset of the third-quarter of 1973. The table compares the product imports required under these circumstances with our base forecast (presented in Table II-2.

The estimates made in Table II-5 are based on the following three assumptions:

- Crude import increases required in excess of average crude imports during the first two-quarters of 1973 originate in Mid-East countries plus the African nations of Egypt, Libya, Tunisia and Algeria. These increases, as well as crude imports from these areas at their rate achieved during the

TABLE II-5

GASOLINE AND DISTILLATE SUPPLY
COMPARISON OF BASE CASE AND INTERRUPTION
OF ARAB IMPORTS

PAD's I-IV	73:3Q Base Case	73:3Q Arab Interruption	73:4Q Base Case	73:4Q Arab Interruption	74:1Q Base Case	74:1Q Arab Interruption	74:2Q Base Case	74:2Q Arab Interruption
Refinery Inputs								
Crude	10,754	9,735	10,685	9,735	10,644	9,735	10,875	9,735
Reruns	107	97	106	97	106	97	108	97
Gasoline								
Net Demand	6,107	6,107	6,059	6,059	5,942	5,942	6,174	6,174
Yield on Crude & Reruns	5,376	4,867	5,287	4,818	5,160	4,719	5,437	4,867
NGL's & Other Hydrocarbons	646	574	687	626	697	637	652	574
Domestic Refinery Output	6,022	5,441	5,974	5,444	5,857	5,356	6,089	5,441
Import Requirement	85	666	85	615	85	586	85	733
Distillate								
Net Demand	2,708	2,708	3,196	3,196	3,289	3,289	2,938	2,938
Yield on Crude & Reruns	2,498	2,261	2,633	2,389	2,689	2,458	2,528	2,261
Import Requirement	210	447	563	807	600	831	410	677
Domestic Refining Parameters								
Refinery Operating Rate (%)	94.0	85.1	93.0	84.7	92.0	84.1	94.0	84.1
Gasoline Yield on Crude & Reruns (%)	49.5	49.5	49.0	49.0	48.0	48.0	49.5	49.5
Blending Rate (%)	11.8	11.8	13.0	13.0	13.5	13.5	11.8	11.8
Distillate Yield on Crude & Reruns (%)	23.0	23.0	24.3	24.3	25.0	25.0	23.0	23.0

first two quarters of 1973, would be interrupted.

- Domestic refining rates would be adjusted downward to match crude supply, but all other refining parameters would remain constant. In addition, no increased drawdown of crude or product stocks is assumed in response to the crude interruption
- The Arab interruption is applied only to the U. S ; no curtailments are applied to other consuming countries supplying the U. S. except the Caribbean. Also, other OPEC countries are assumed to continue supply the U. S. at normal rates.

2. CONCLUSIONS

The table, below, summarizes the estimating results detailed in Table II-5

(mb/d)

	3 & 4Q, 73		1 & 2Q, 74	
	Base	Curtailed	Base	Curtailed
Refinery Inputs	10,720	9,735	10,760	9,735
Gasoline				
Demand	6,080	6,080	6,060	6,060
Domestic Supply	6,000	5,440	5,970	5,400
Imports	80	640	90	660
Distillate				
Demand	2,950	2,950	3,110	3,100
Domestic Supply	2,570	2,320	2,610	2,360
Imports	380	630	500	750

As indicated above, the potential import increase in response to crude import interruption, affecting Arab imports alone, would be substantial. Product imports would increase on average by about 1 million barrels per day; without major alteration of domestic refining states, this requirement would predominate as gasoline. Adding to this impact on domestically-refined supply, reductions in Caribbean products available to the U. S. would add about an additional shortfall of about 1. 2 million barrels per day.

Domestic stocks could moderate the rate of impact on total domestic supply for about one quarter at forecast demand rates. Beyond this point, Eastern Hemisphere imports would have to expand rapidly or demand would need to be reduced domestically by direct measures such as gasoline rationing.

From this, we conclude the following:

- The U.S supply position is vulnerable even to a limited crude interruption concentrated only on U.S crude imports directly from Arab states. At these levels about 1 MMB/D), we do not believe Caribbean refining capacity or Eastern Hemisphere capacity is adequate to replace lost output from domestic refineries.

- If, as is more likely in case of an Arab curtailment, the curtailment is extended to the Arab crude run through Caribbean refineries to provide product imports to the U.S., the domestic supply-demand gap more than doubles (to 2.2 MMB/D). At these rates, domestic stocks can only buffer this loss for about one quarter, after which direct demand reduction measures would be required.

- If, as is possible in light of rising OPEC solidarity in recent years, all OPEC shipments to the U.S. are curtailed, U.S. supply will fall by up to 5 million barrels per day, or about 25 percent. At these levels, extremely severe economic impacts would occur.

Overall, then, the vulnerability of U.S. supplies of refined oils appears highly vulnerable to an Arab crude curtailment. If this curtailment cascades to other OPEC countries (especially Venezuela) the domestic economic impacts would be extremely severe.

APPENDIX II-A

CARIBBEAN PRODUCTS AVAILABLE TO THE UNITED STATES

For the purposes the estimates in the section, the Caribbean was defined to include the following countries:

Bahamas
Netherlands Antilles
Panama
Trinidad
Puerto Rico
Virgin Islands
Venezuela

The total volume of refined products from these countries available for exportation to United States markets is assumed to equal the excess of Caribbean output over local Caribbean demand.

For prior years, Caribbean output (in MB/D) has roughly equalled 95 percent of the reported end-of-year refining capacity. To estimate output for 1973-77, new refinery construction and expansions scheduled for completion during this period and was added to reported 1972 end-of-year capacity (Table A-1). These estimates of Caribbean refining capacity through 1977 were then multiplied by .95 to project Caribbean refinery output over the period.

TABLE A-1: SCHEDULED ADDITIONS TO CARIBBEAN REFINING CAPACITY

Company	Location	Additional Capacity	Approx. Completion
Moratti Group	Luana Point, Jamaica	125,000	1975
		125,000	1976
Bahamas Oil Refining	Freeport, Bahamas	200,000	1973
		125,000	1976
Kardar Canadian Oil Ltd	Grand Bahamas Isl.	125,000	1977
		70,000	1974
Northville Industries	Bonaire, Neth. Antilles	130,000	1976
Venezolano del Petroleo	Lake Maricaibo, Venez.	100,000	1975
Refineria Panama	Las Minas Bay, Panama	25,000	1974

Local product demand for the same period was estimated by assuming a 5 percent annual rate of growth, added to 1971 Caribbean demand figures which were derived from the Bureau of Mines' "International Petroleum Annual 1971." Finally, local demand was subtracted from total output to obtain the amounts available for export. Further, it was assumed that the mix of products available would be proportional to the estimated product yields of Caribbean refineries, i.e., 10 percent gasoline 11 percent distillate, 55 percent residual fuel. The results of this approach are shown in Table A-2, on the next page.

TABLE A-2: CARIBBEAN SUPPLY, DEMAND, AND POTENTIAL EXPORTS

	1973	1974	1975	1976	1977
Refining Capacity	4,054	4,419	4,374	4,754	4,929
Output	3,851	3,942	4,155	4,516	4,683
Local Demand	761	799	839	881	925
Available for Export	3,090	3,143	3,316	3,635	3,758
Shores:					
Gasoline	309	314	332	364	376
Distillate	340	346	365	400	413
Residual	1,760	1,791	1,890	2,073	2,140
Other	681	692	729	798	829

APPENDIX B

UNITED STATES REFINING CAPACITY THROUGH 1977

Estimates of United States refining capacity through the year 1977 were obtained by adding scheduled refinery completions during each of the years 1973-77 to the end-of-year refining capacity for the previous year. Thus, starting from a base of 13,992 MB/D at the end of 1972, we add in the following to produce our estimates:

TABLE B-1. SCHEDULED ADDITIONS TO UNITED STATES REFINING CAPACITY

End-of-Year 1972 13,992,000

New Completions 1973:

Company	Location	Added Capacity
Coastal States	Corpus Christi, Texas	50,000
Gladieux Refining	For Wayne, Indiana	500
Laketon Refining	Laketon, Indiana	1,500
Southwest Oil & Refining	Corpus Christi, Texas	52,000
Texaco	Lawrenceville, Ill.	10,500
Conoco	Wrenshall, Minn.	2,500
ARCO	Carson, California	20,000
Texaco	Anacortes, Wash.	15,000
Total		152,000

End-of-Year 1973 14,144,000

New Completions 1974:

Company	Location	Added Capacity
Apco Oil Corp.	Arkansas City, Kansas	20,000
Pacific Resources Inc.	Barbers Point, Hawaii	15,500
Socal	Perth Amboy, N.J.	75,000
Clark Oil Co.	Wood River, Illinois	45,000
ARCO	Philadelphia, Pa.	15,000
Famariss	Lovington, New Mexico	29,500
Famariss	Monument, New Mexico	30,000
Sohio (B.P.)	Marcus Hook, Pa.	50,000
Amoco	Whiting, Indiana	55,000
New England Petroleum	Oswego, New York	150,000
Total		485,000

End-of-Year 1974 14,629,000

New Completions 1975:

Company	Location	Added Capacity
Georgia Refining Co.	Brunswick, Georgia	200,000
Exxon (2 locations)	Baton Rouge, La. & Bayway, N.J.	100,000
Urich Oil	San Francisco, Cal.	28,000
Marathon	Robinson, Illinois	75,000
Conoco-Dillingham Oil	Barbers Point, Hawaii	50,000
United Gas Pipeline	Pascagoula, Miss.	150,000
Mobil Oil	Paulsboro, New Jersey	150,000
Total		753,000

End-of-Year 1975 15,382,000

New Completions 1976:

Company	Location	Added Capacity
Pittston Co.	Eastport, Maine	250,000
Odessa Refining	East Coast (No Firm Site)	120,000
Socal	Richmond, California	175,000
Exxon	Baytown, Texas	250,000
Pacific Resources Inc.	Barbers Point, Hawaii	80,000
Pennzoil	Pascagoula, Miss.	150,000
Total		1,025,000

End-of-Year 1976 16,407,000

New Completions 1977:

Company	Location	Added Capacity
Texaco	Louisiana	200,000
Energy Corp of La.	New Orleans, La.	200,000
Pennzoil	Pascagoula, Miss.	50,000
Total		450,000

End-of-Year 1977 16,857,000

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APPENDIX C

DISTILLATE DEMAND ESTIMATION

The approach used to estimate distillate demand for PADs I-IV is based on dividing consumption into three components capable of being analyzed separately, as follows:

- Winter demand;
- Summer demand; and
- Incremental demands resulting from increased gas curtailment.

Winter demand for distillate is clearly divisible into two parts:

- That which is responsive to changes in weather patterns (including temperature and wind chill factors); and
- That which is not directly affected by weather.

The Office of Oil and Gas (DOI) estimates[1] that about 62 percent of winter distillate demand is weather sensitive -- utilized for heating or electric power generation. However, since future weather patterns are not predictable within a reasonable degree of confidence (except possibly in the very short run), any forecast of winter distillate demand must be accompanied by an assumed level of weather severity. To meet this requirement, the weather responsive portion of demand for each of the past six winters (1967/68-1972/73) was adjusted to reflect demand under "normal" climatic conditions. Based on Bureau of Mines demand data and weather adjustment factors compiled by OOG[2] normalized demands were computed for each of these previous winters. Forecasts of normal winter distillate demand for the coming winters (1973/74-1976/77) are, thus, an extrapolation of the historical growth trend derived from normalized data for previous winters. The results show a projected rate of increase of roughly 5 percent per year for winter (October 1 - March 31) distillate requirements.

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[1] Office of Oil and Gas (DOI), "Analysis of PAD I-IV Industry Distillate Protection Capability for Winter 1972/1973," September 8, 1972.

[2] Ibid

TABLE C-1: Winter Distillate Demands and Weather Adjustments
(in 000's of barrels)

Winter	Actual	% Colder (Warmer) than Normal	Normal
67-68	492,240	3.5	481,560
68-69	506,030	3.1	496,600
69-70	532,110	8.3	506,820
70-71	540,860	1.8	534,930
71-72	558,330	(2.6)	567,570
72-73	611,750	(3.3)	624,690
73-74*	----	---	655,930
74-75*	----	---	688,730
75-76*	----	---	723,170
76-77*	----	---	759,330

*Projected using 5% annual growth rate.

Summer distillate demand estimation is more straightforward. Since weather does not appear to significantly affect distillate consumption during the second and third quarters of the year, no adjustment of actual demand data is required. By calculating an average summer to summer growth rate and extending it through the forecast period, estimates of summer distillate demand are derived. In this case the projected growth rate is approximately 7 percent per year for the period April 1 through September 31.

In addition to these normal demand increases, some adjustment for the effects of recent natural gas curtailments on distillate demand is necessary. Historical trends do not accurately reflect this substitution of fuels because its major impact has only been felt over the last couple years. To better account for the effects of this demand shift, estimates of gas curtailments for the winter of 1973/74 by the Federal Power Commission's Bureau of Natural Gas were employed. Based on these numbers, it was determined that incremental curtailments in PADs I-IV could be expected to result in additional distillate demands of roughly 70 MB/D. This amount added to the demand estimate for the coming winter produces a total forecast increase in the heating season distillate requirement of 7.6 percent over the normalized demand for last winter. However, it is assumed in calculations for future winters that the natural gas situation will be improved to the extent that no additional curtailments will be required.

APPENDIX D

CALCULATION OF EASTERN HEMISPHERE DISTILLATE IMPORT REQUIREMENTS

For our purposes, the eastern hemisphere distillate import requirement was defined to equal total domestic distillate demand (consumption net stock changes) less domestic distillate output and the maximum distillate imports available from the major refiners and exporters in the Caribbean (Bahamas, Netherlands, Antilles, Panama, Trinidad, Puerto Rico, Virgin Islands and Venezuela). Our method of calculating maximum Caribbean imports is described in Appendix A. This appendix describes the refining algorithm used to calculate the eastern hemisphere distillate import requirement, given total domestic demand for both distillate and gasoline.

Derivation of Algorithm

The algorithm derives from five refining equations and two demand-supply balance equations. The notation is as follows:

Refining Capacity

C_s = domestic crude refining capacity, stream day basis
C_c = operable crude refining capacity, calendar day basis

Refining Inputs

U = domestic crude runs
E = domestic reruns
N = NGL's and other hydrocarbons blended

Refinery Operating Characteristics

R = domestic refinery operating rate, calendar day basis
Y_g = gasoline yield rate on crude plus reruns
Y_d = distillate yield rate on crude plus reruns

Outputs

O_g = domestic gasoline output
O_d = domestic distillate output

Demand and Imports

D_g = total domestic gasoline demand (domestic demand net stock changes)
D_d = total domestic distillate demand (domestic demand net stock changes)
I_g = gasoline imports
I_{dc} = maximum Caribbean distillate imports available
I_{de} = eastern hemisphere distillate imports required

Based on this notation the seven equations are as follows:

Refining Equations

(1) $C_c = K_1 C_s$
where K_1 = assumed calendar day - stream day capacity relationship

(2) $U = C_c \cdot R$

(3) $O_g = (U \cdot K_2) Y_g \cdot K_3$
where K_2 = assumed rate of reruns $(1 + \frac{F}{U})$
and K_3 = assumed rate of blending $(1 + \frac{N}{(U \cdot K_2) Y_g})$

(4) $O_d = (U \cdot K_2) Y_d$

(5) $Y_d = K_4 - Y_g$
where K_4 = combined gasoline plus distillate yields on crude plus reruns

Balance Equations

(6) $D_g - O_g - I_g = 0$

(7) $D_d - O_d - I_{dc} - I_{de} = 0$

Substitution among these seven equations yields:

$$D_d - C_s \cdot R \cdot K_1 \cdot K_2 \cdot K_4 + \left(\frac{D_g - I_g}{K_3}\right) - I_{dc} - I_{de} = 0$$

The values of the constant terms assumed in the short range and longer range estimates displayed in Table 2 (Section II) were as follows:

	Short Range	Longer Range
K_1	0.95	0.95
K_2	1.01	1.01
K_3	per Table II-2	1.15
K_4	per Table II-2	0.71

SECTION III

GOVERNMENT POLICY OPTIONS

A. OVERVIEW

The preceding two sections traced the evolution of gasoline and distillate demand and supply problems since 1966 and projected their outlook through 1976. Overall, the outlook in the short-term is not optimistic, on three major counts:

- Refining bottlenecks, domestically and in U. S.-dedicated refining areas offshore, will maintain a tight supply situation through 1976.
- On the supply side, preventing further deterioration through 1976 depends on availability of foreign crude and refined products as well as high level of performance from domestic refineries.
- Neither crude and products import availability nor domestic refining at high levels is assured:
    - -- Internationally, oil affairs are in a state of rapid flux; potential developments could adversely affect Eastern Hemisphere sources of crude and products, upon which the U.S must depend to an unusual degree for the short-term. An adverse Eastern Hemisphere events could disrupt traditional sources of U.S supply in the Western Hemisphere where these sources depend on Eastern Hemisphere crude. U.S. supply vulnerability to any Arab, or worse, OPEC-wide crude interruptions is high immediately and this vulnerability quite likely will increase through 1976.
    - -- Although to a lesser degree, domestic oil supply affairs also are in a state of flux. It will be necessary to operate domestic refineries at rates never achieved before on a sustained basis; this must occur simultaneous with a restructuring of the domestic supply system to accommodate rapidly increasing levels of imports.

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The latitude for "normal" governmental policy initiatives to affect the supply and the demand situation through 1976 is small. Although many things can be done to assure eventual recovery from the current demand-supply problems, the practical constraints caused by typically long supply and demand leadtimes largely delay their effect beyond 1976. In the interim, the remedies which are available represent serious tradeoffs:

- Pursuing traditional lines of government involvement in economic affairs risks the outcome on voluntary consumer sacrifice and the private performance of the petroleum industry.
- Alternatively, extensive governmental intervention risks the outcome on the skill in "hands-on" management of the most complex and pervasive component -- energy -- of a large, sophisticated, economy geared to market rather than centralized management.
- And, with either approach, issues of equity, market competition, windfall gains and losses, and deterioration of other desirable national objectives -- growth, environment, economic stabilization, etc. -- are involved.

This section attempts to define the nature of the problem, to delineate the characteristics of a comprehensive recovery strategy through the moderate term, and to identify the key options available for various elements of such a strategy. It does not recommend a specific set of policies to implement this strategy, simply because the detailed study needed to advocate a single course of action is beyond the scope of this effort.

B NATURE OF THE PROBLEMS THAT NEED TO BE SOLVED

In the broadest sense, the problem supply and demand situation through the 1976 period is a delicate one.

1. SHORT-RUN SUPPLY PROBLEMS

Turning, first, to the supply side, the situation exhibits the following problems:

- The period will require a rapid acceleration of crude imports. This is unavoidable for two reasons:

    -- Domestic crude production currently is operating nearly flat out and most producting regions are on the decline rate. Known opportunities to expand production are small relative to import requirements (Texas: 388 MB/D; Elk Hills: 160 MB/D); opportunities to increase output from producing wells through workovers, new equipment, and new gathering lines may require substantial crude price increases during a period of general inflation, while the magnitudes of the increases are unknown.

    -- Substantial increases from new exploration and new development appear to be several years away; before they can increase domestic supply above current levels, they must offset further decline from existing producing regions.

- Even with sufficient crude (from a combination of domestic and foreign sources) the period will require further acceleration in products imports; rather than being spread over the full range of oil products, this growth will continue to concentrate in heating fuels.

    -- Through 1975, domestic demand under current conditions will expand faster than domestic refining.

    -- This domestic refinery bottleneck cannot be completely relieved by U. S. -dedicated refinery expansion offshore; the combination of domestic and U. S. dedicated foreign refinery capacity expansion probably will grow less rapidly than domestic demand through 1975.

    -- Similar to crude, substantial increases in new domestic and U. S. -dedicated refinery capacity appear to be several years away.

- The security of a key portion of the incremental foreign supply required to offset domestic crude and domestic refining bottlenecks is not high:

  -- Domestic availability of Eastern Hemisphere crude depends on stable Arab-Israeli relations in the Middle East; an instability in these relations has a high potential to cascade through the entire U.S import supply system due to the growing solidarity of OPEC countries.

  -- Eastern Hemisphere products imports largely depend on variable local demand conditions (especially European weather) and temporary supply conditions (undedicated surplus refinery capacity and Eastern Hemisphere crude).

- Even short of any interruption in imports caused by Mid-East tentions, the stability of the traditional portion of incremental foreign supply is somewhat clouded:

  -- Venezuela is operating flat out and on the decline rate.

  -- Canada already has imposed controls on exports to the U.S. by freezing their domestic price (in the face of rapidly rising prices for their imported crude and the prior underpinning of Canadian exports by substitution of cheaper foreign imports for Canadian exports to the U.S.); has levied an export tax on crude; and has announced construction of pipeline capacity to move oil from their western fields which supply the U.S. mid-continent to their eastern areas now dependent on foreign imports.

  -- Both Canada and Caribbean exports to the U.S. depend on the same Eastern Hemisphere crude sources whose security is not assured.

- Internal to the U.S., there is limited potential to provide a short-term supply hedge commensurate with the uncertainties of foreign supply:

  - -- There is little short-run crude reserve capacity (again, because U. S. fields are operating flat out and new additions first must offset capacity yet to be lost due to declining productivity of existing fields)
  - -- If extra domestic and foreign crude becomes available, little spare capacity exists to refine it domestically and immediately offshore or to store greater amounts of crude.
  - -- If domestically refined and foreign products become available, little spare capacity exists to store it, too.

2. SHORT-RUN DEMAND PROBLEMS

In the period through 1976, the problems on the demand side of the situation are equally difficult:

- There is no clear prospect of a reduction in "fundamental" oil demand due to substantial changes in economic conditions, transportation practices, or gaining competitive momentum of non-petroleum fuels.
- The prospects for a reversal of current short-run fuel substitution effects are adverse rather than favorable:
  - -- Natural gas curtailments are increasing rather than decreasing; also, attempts to stimulate new interstate supply through price increases are effectively stopped by the legislative process and by the courts (specifically, 180-day emergency sales have been stayed by the U. S. Court of Appeals).
  - -- Coal supply is stagnant, principally due to a lack of long-term commitments to facilitating burning of SIP-unacceptable coal in steam electric plants in the eastern areas which now rely on oil for boiler fuel.

3. RELATIONSHIP BETWEEN SHORT-TERM AND MODERATE-TERM PROBLEMS

The key feature which complicates these short-term problems and limits the scope of governmental action is the leadtime characteristic of petroleum supply and demand. Because of these leadtimes, these problems may or may not be resolved shortly beyond

1976, largely depending on the degree and kinds of actions aimed at this moderate-term period which are taken before 1976. This dependence of the moderate-term recovery on short-term actions occurs in two main ways. The actions of most concern are initiatives taken now which directly define the oil policy environment during the moderate-term. Key examples are crude supply policies such as OCS leasing and superports.

The more subtle actions concern initiatives taken with respect to the short-term problems which affect policy expectations in the moderate-term. In this case, key examples include price controls, import controls, and, generally, the role in energy affairs the government defines for itself through its near term actions -- specifically with respect to mandating allocations, rationing and intervention in areas of state authority in siting and permitting environmental protection, market demand prorationing and others.

The principal moderate-term problems deriving from the short-term situation which governmental policy should resolve are:

- The moderate-term availability of crude supply remains speculative:
  - -- Despite efforts to stimulate domestic crude supply, the likelihood of continuing dependence on foreign crude -- especially from Eastern Hemisphere areas -- is high; to date Federal policy has dealt with long-term self-sufficiency without resolving the problems attendant a distasteful but necessary moderate-term dependence on Middle East crude.
  - -- Large uncertainty still exists in three crude supply areas:
    - Transportation of Alaskan North Slope to the "lower-48"
    - Access to new crude provinces offshore in Alaska and East Coast
    - Future operations in the Santa Barbara channel and other channel areas in the California OCS

- A number of key decisions affecting moderate-term supply logistics revolve around undecided areas of government policy.
  - -- Of first priority are the basic supply uncertainties outlined immediately above; until these are clarified, the risks of downstream refinery, pipeline, and other transportation investment remains large.
  - -- Additionally, uncertainty about the timing and location of superports is affecting the siting of refineries and pipelines and the ordering of tankers.
- Administrative bottlenecks at all governmental levels are substantially complicating the leadtimes and investment decision-making process at all levels of the downstream supply system; for example:
  - -- Rights-of-way acquisition time for pipelines has lengthened construction by up to two years.
  - -- East Coast "grass roots" refinery construction is at a standstill.
- Generally, price controls, under the economic stabilization program, are clouding the supply expansion process in at least two ways:
  - -- Crude prices may not be stimulating short-run production increases from producing wells which could benefit from workovers, new equipment, and new gathering installations; simultaneously, they may be causing abandonment of some marginal wells earlier than otherwise might occur.
  - -- Other price controls are bottlenecking the availability of capital equipment; the case of tubular goods is a current example.

C. ELEMENTS OF AN APPROACH TO SOLVING OIL SUPPLY PROBLEMS

The practical constraints of oil supply and demand leadtime reduce the potential objectives of a "normal" governmental program to deal with the oil problems outlined above. In our opinion, these objectives reduce to three:

- Setting a clear course which provides investment confidence adequate to stimulate sufficient moderate-term capacity and which expedites the process of putting it in place.
- Minimizing the risk of exposure to a tight demand-supply situation in the short-run.

- Preparing in advance to deal with further short-term deterioration and developing mechanisms to signal the need to engage a contingency apparatus.

In this portion of the section, we discuss the general elements of a strategy to meet these objectives, the governmental policy steps already taken, and several general principles we believe apply to finally selecting detailed policy initiatives. The specific options available with respect to each element of the strategy are discussed in the next portion of this section.

1. SEVEN-POINT STRATEGY TO MEET SHORT TO MODERATE-TERM OBJECTIVES

To meet the first of the three objectives outlined above, three broad steps are necessary:

- Assure a reliable crude supply;
- Reduce administrative and other bottlenecks which are increasing the individual leadtimes of components of the supply system and decouple, where possible, the sequential nature of the downstream investment process; and
- Reverse the interim pressure on oil demand stemming from short-term substitutions caused by lagging supplies of alternative fuels.

In turn, to meet the second objective, above, two broad steps are required:

- Trim as much discretionary demand as is possible;
- Facilitate maximum performance of the existing supply capability.

Finally, in order to meet the third objective, two broad steps are required:

- Develop a specific contingency plan, gauged to different levels of shortage of different types of petroleum products;
- Improve current data, information, and analytical tools to a level compatible with managing "close to the edge".

Generally, specific policy options available to the government follow the lines of these seven strategic steps. The seven strategic steps, however, are not independent among themselves. In selecting options to accomplish these steps, it is important to produce a consistent set of initiatives. For example, assuring moderate-term crude availability bears on the degree of supply-demand tightness in the short-term -- without moderate-term crude assurance, refinery construction will be depressed even in the short-run. Alternatively, steps taken in the short-run to facilitate maximum performance of the existing supply system -- for example, in the area of price control -- affect the moderate-term certainty of adequate returns on downstream conversion and logistical capacity needed to utilize future crude supply, if assured.

2. POLICY STEPS ALREADY PROPOSED OR IMPLEMENTED

Beginning in April, 1973 three major steps were proposed or implemented which relate to the first two objectives we propose. These are:

- Abandonment of the mandatory oil import quota system;
- Proposed decontrol of the field prices of natural gas; and
- Accelerated scheduling of OCS lease sales.

In essence, the new oil import system did three things. First it freed oil imports from volumetric quotas while providing tariff incentives for domestic exploration, development and refinery construction. In the manner in which it set interim tariff schedules and exempted existing quota allocations from duties, it attempted to provide some adjustment assistance to independents and inland refiners. This adjustment assistance, however, largely has been negated by price rises of foreign crude and products; consequently, some amount probably (200 MB/D) of refining capacity has been underutilized.

In light of these developments, the fee levels scheduled for 1975 probably should be reviewed; in addition, tariff differentials between fuel oil and gasoline might be removed earlier than now scheduled (1975). This could eliminate the current products import bias, thereby broadening short-term product import option, and potentially could encourage the addition of gasoline converting capacity in U. S. -dedicated refining areas offshore.

The second major initiative -- decontrol of field prices for natural gas -- is important but, as yet, has been largely ineffective. Attempts to obtain legislative relief are stopped; similarly, efforts to employ emergency powers to decontrol temporarily have been halted by the courts. No alternative remedy is readily apparent.

The final major action, accelerated OCS leasing, is important but probably mainly in the post-1976 timeframe. Although greater access to more attractive "lower-48" provinces is vital, a number of potential alternatives for assuring maximum OCS development have not been touched yet.

3. TRADEOFFS ASSOCIATED WITH GOVERNMENTAL POLICY OPTIONS

Four major categories of tradeoffs tangentially related to oil demand and supply arise as counterpoints of options to increase oil supplies and decrease oil demand. These are:

- Equity of income effects -- based on the regressive nature of price increases on lower income individuals and families;
- Windfall profits -- based on increasing profit margins likely to accrue from letting price bring demand into equilibrium with fixed short-term supplies, especially given the magnitude of price rises likely to be associated with a relatively price-inelastic good such as oil;
- Competitiveness of energy industries -- based on the naturally weak position of non-integrated independents (mainly at the refining and marketing levels) in a highly vertically integrated industry faced with raw material shortages; and

- Environmental quality -- based on certain energy demand penalities and supply inflexibilities currently associated with governmental environmental regulation and with separate public actions now constraining the rate of supply adjustment.

In formulating energy policy, it is important to weigh these tradeoff areas but to keep them in proper perspective. In our opinion, current oil debate is overdrawn on these issues, for several reasons:

- Equity effects, although important, can be corrected through the general personal tax mechanism; the solution can take the form of general reform or narrow relief from specific energy-related income effects. Additionally, reducing the current tax burden of final energy prices -- accruing from state taxes on crude and sales of refined products, similar Federal excises, lease bonuses and royalty payments -- could offset general oil price increases, although not necessarily redistribute the income effects.

- Windfall profits, although troublesome in the short-run, can be reduced directly through corporate tax mechanism, excise taxes on crude, or by eliminating the tax subsidies now afforded energy industries. Currently, this issue is poorly drawn; adequate profits to stimulate necessary domestic energy-related investment -- rather than incremental short-run earnings increases -- is the appropriate issue. If profit adequacy were determined, at least half a dozen tax provisions affecting oil industry income could be altered to absorb inappropriate profit windfalls.

- Maintaining industry competitiveness -- to the extent a convincing case for a serious lack of competition can be made -- is a problem which is more tedious to correct than equity and windfall profits effects (and only relatively more so, since obtaining tax legislation is not an expeditious process). Particularly in the short-run, it is important not to overly equate the independent, non-integrated sector of the petroleum market with competitiveness. Economic units which lived off surplus may be a poor device for insuring future competitiveness in an era of shortage, unless the government chooses to subsidize them, directly or indirectly, in perpetuity.

- Environmental quality tradeoffs currently are painted large, where really they probably are small. The issue -- given the desirability of protecting the environment -- mainly is one of rate of adjustment and of a sensible course of action on the part of government and industry. Much governmental and private industry latitude exists to meet energy and environmental needs at low cost and in a timely manner.

In the subsequent discussion of Federal options, we point out the places where these four areas of tradeoffs exist. Our general view with respect to how they should be weighed is that attempting to treat these problems directly with oil supply and demand policy leads basically to doing either nothing or the wrong things; accordingly, they would be better addressed in the context of a sound energy demand and supply policy, once decided, rather than deciding an energy policy to solve them directly.

D. SPECIFIC OIL POLICY OPTIONS

In the preceding portion of this section we identified the seven broad elements of a strategy to achieve what we believe to be practical objectives for the short and moderate-term. Here, we outline and comment on the range of policy options available to the government with respect to each of the seven strategic elements.

1. OPTIONS FOR ASSURING AN ADEQUATE CRUDE SUPPLY

Previously, we identified the following elements of the crude supply problem:

- Declining domestic production and long leadtimes need to increase domestic supplies;
- Rapidly increasing reliance on unstable Eastern Hemisphere crude supplies; and
- Deterioration of traditional Western Hemisphere supply relations, coupled with the destabilizing influences of Eastern Hemisphere events on these western supplies.

There are three ways to affect the future crude supplies in the face of these problems:

- Decrease U.S. reliance on foreign crude by greater development of conventional domestic crude sources;
- Stabilizing the complete foreign crude situation; and
- Exploiting non-conventional domestic crude sources (through oil shale and synthetic crude from coal).

For the purpose of this discussion, we set aside the third option, above, because it is of minimal significance in the short and moderate-term (certainly pre-1980 and more likely pre-1985).

The two remaining options are interrelated, but not because they substitute for each other. Specifically, domestic crude self-sufficiency should imply a capability rather than a practice; the reliability of foreign crude largely depends on the alternatives available to the U.S.; therefore, a greater capability for crude self-sufficiency will stabilize the foreign crude situation from a practical standpoint.

Conversely, stabilizing foreign crude supply availability does not hinge entirely on a domestic capability to be self-reliant with respect to crude. Rather, it depends on some form of economic power to act as a bargaining chip in international oil-diplomacy.

In fact, it may be imprudent to embark on an announced course of domestic crude self-sufficiency, particularly as a substitute to concurrently pursuing independent solutions to the instability of foreign crude supplies. Three things support this view:

- It is unlikely that the U.S. can develop a self-sufficiency capability in the short-to-moderate-term.
- Even becoming self-sufficient in the longer term, if possible, may be inordinately expensive, particularly if exploitation of economically marginal crude sources, synthetic crudes, and exotic substitutes for oil-based fuels must be employed.
- An announced course of self-sufficiency -- particularly if not confined to capability rather than practice -- invites use of oil as a weapon in the short-run when no alternative capability exists.

Accordingly, it may be well to pursue jointly increased domestic crude supply -- considering capability as an alternative to literal complete dependence on domestically produced crude -- and independent avenues to a stabilized foreign crude supply.

2. OPTIONS FOR INCREASING DOMESTIC CRUDE SUPPLY

As indicated in the first section of this report, a number of long standing crude supply policies contributed to the decline in domestic crude producing capacity. Largely, the reform of these policies make-up the options for restoration of such capacity. The two key areas of concern are improved economic returns from domestic exploration and development and increased access to good exploratory prospects.

In the moderate-term, improved access has been afforded by accelerated leasing; additionally, it can be improved by a resolution of the status of the transport of North Slope oil to the "lower-48", where any resolution -- either favoring the trans-Alaskan or the McKensie Valley route -- will allow the investment process to proceed. Similar resolution of the operational status of the Santa Barbara channel could increase access to crude prospects.

With respect to improved economics, the following steps could be beneficial in increasing U. S. crude supply capability:

- Relaxation of price controls on new crude and a firm plan to decontrol old (and, in turn, product price relaxation and decontrol);
- Removing the disincentives associated with the market-demand prorationing apparatus; at a minimum these include:
  - Per field rather than per well allowables;
  - Compulsory unitization of field operations;
  - Better recognition of depth-cost relationships in depth allowables schedules, particularly offshore;
  - Short of field allowables, extending per-well allowables separately to multiple completions;
  - Setting top schedule allowables equal to MERs; and

- Where national policy dictates spare productive capacity, reimbursing its cost directly through direct acquisition, contract, or regulation coupled with price decontrol.

- Import control through the new tariff-based import system.

- Decreased incentives for foreign investment through lower U.S. tax deductability of foreign royalty payments, taxes on repatriated profits, or direct controls on foreign investment.

- Relaxation of price controls on bottlenecked capital goods such as tubular goods.

The issue here largely is one of the price the U.S. is willing to pay and the form in which it is paid. Also, a selection among these options requires a careful balancing of short and long-run interests. For example, the disincentives to secondary recovery projects and maintaining production from marginal wells must be balanced against a relaxation of the restraint on flush reservoirs through reform of prorationing and the threat to the underpinnings of prorationing occasioned by removal of volumetric quotas. Similarly, overly punitive measures taken against foreign investment must be balanced against the need to continue development of foreign oil for import to the U.S. Finally, the different kinds of new supply called forth by alternative price and tax schemes (new field wildcats versus increased development of known reservoirs versus upgrading of existing wells versus more secondary and tertiary recovery) need to be weighed carefully.

Particularly in light of these complexities, it would appear that the best policy course would tend toward lesser rather than greater detailed governmental economic control. Consistent with this approach, the most immediately effective and simple policy actions might be:

- Relaxation of price controls on new oil;

- Changing the basis for bonus payments from leases to royalties; and
- Developing a Federal device to directly compensate spare productive capacity.

3. OPTIONS FOR STABILIZING THE FOREIGN CRUDE SITUATION

As indicated previously, a domestic capacity for crude self-sufficiency should add a stabilizing influence to foreign crude supply. In addition, a number of independent steps might be pursued in this vein:

- Attempt to bring greater harmony to U. S. relations with Western Hemisphere sources of supply, particularly Canada.
- To the extent that domestic prices need to be high to call forth domestic crude (or subsidies are required to support a domestic synthetic industry) long-term commitments might be encouraged to support development of vast Canadian and Venezuelan tar sands supplies.
- With respect to Eastern Hemisphere sources, several steps might be taken:
  - -- Direct intervention in oil affairs by the Federal government as a substitute for leaving oil diplomacy in the hands of the multi-national oil companies;
  - -- Direct efforts to develop mutually beneficial economic relationships with oil producing countries, including greater downstream economic participation in the petroleum industry;
  - -- Cartelization of oil consuming countries as a counterpoint to the producing country cartel; and
  - -- Development of consuming country pooling relationships to deal with supply interruptions.
- Developing an emergency storage capability domestically.

With respect to all producing areas, the effectiveness of these measures -- assuming a need to prevent oil from completely dictating U. S. foreign policy -- is dependent on U. S. economic leverage on oil producing countries. With respect to the Middle East, the undeveloped nature of their economies tends to limit the possibilities for economic leverage and indicates a need to have an alternative crude supply capability for the U. S. In turn, the need for this supply to be domestic depends on U. S. ability to develop economic leverage with respect to other producing countries outside the Mid-East and for these other countries themselves to become self-reliant with respect to Mid-East crude.

The important areas in this latter respect are, first, Canada and, then, Venezuela. Within these countries, however, decoupling future U. S. -dedicated exports from Mid-East events may require paying a premium price to support development of more economically marginal resources, such as tar sands, which otherwise would remain untapped. These price premiums may be unattractive in comparison to exploiting similar U. S. resources. So, again, the need for U. S. capability to be internally self-sufficient may be necessary, but based on the broader issue of least cost.

With respect to other actions potentially available for stabilizing foreign supplies, it would appear that the logic of the lack of a device to develop a strong economic lever over the Middle East leads back to a self-sufficiency capability for the U. S. In our opinion, greater producing country investment downstream is a limited tool in the face of vast, liquid, discretionary wealth of Arab countries and granting them sufficient insight to recognize that their downstream investment commitments should be kept at levels which do not erode their crude oil power. As they develop further economically and if their internal economies become directly dependent in downstream investments -- perhaps through Arab employment in refining and transportation -- this tool may increase in strength. Short of that, it will remain weak, and certainly so in the short-to-moderate-term.

With respect to coordinated action with other consuming countries, the only clear area for forceful cooperation may be military; of course, this is undesirable. Otherwise, other consuming countries' lack of an energy self-sufficiency capability makes them weak partners in providing any joint front to Middle-East producing countries. In fact, they may be, on balance, a detriment, since the only sensible collective action from their viewpoint may be to increase the reliability of their supplies, not by sharing access to their supplies but, rather, by gaining access to U.S. supplies.

4. OPTIONS FOR DECREASING INVESTMENT LEADTIMES

Three things currently are stretching investment leadtimes and increasing the risk associated with downstream oil supply investment domestically:

- Some capital goods and manpower inputs to the supply-building process are bottlenecked by surging demand; others -- such as tubular goods -- are bottlenecked by price controls;
- There is a high level of uncertainty concerning future levels of demand and supply; some of the stem from government indecision; and
- Complicating the general uncertainty is the additional uncertainty caused by bottlenecks in right-of-way acquisition, siting, etc., which stretch out in time the planning horizons with which current decision-making must deal; some of these also involve the government.

With the exception of price controls, the effects of these problems, because they are somewhat intangible, are difficult to quantify. In addition, because government decision-making moves slowly and involves numerous decision-making units -- appropriately in the case of energy due to the high degree of judgment and the large amount of public interest involved -- the situation is not easily remedied.

More expeditious resolutions of specific governmental decisions in two key areas, however, would decrease the uncertainty and risk of current investment decision-making:

- Authorization to construct offshore unloading facilities for VLCCs (now bottled up in the Congressional hearing process); indecision in this area is complicating pipeline and refinery investment decision-making where existing facilities are operating at full capacity (especially Delaware Valley refineries and inland-bound pipelines in PAD I), which never will process or carry crude and products transiting the initial Gulf Coast superports.

- The trans-Alaskan pipeline authorization, also mentioned with respect to future crude supply.

Other areas where the Federal government may be able to influence the pace of decision-making -- independent of whether the ultimate decisions are favorable or unfavorable -- are:

- Bringing a sense of urgency and a perspective of national interest to the sectional and local debate on providing sites for energy facilities;

- Attempting to prioritize NEPA impact statement reviews which involve key energy facilities; and

5. OPTIONS FOR REDUCING PRESSURES OF SHORT-TERM SUBSTITUTIONS AND FOR TRIMMING DISCRETIONARY CONSUMPTION

Two types of actions can reduce substitution pressures on oil demand and aid in reducing lower priority domestic oil consumption. Because the actions related to these two areas of our strategic program are interrelated, both are combined in our discussion here. These actions are:

- Reversal of the short-term substitutions between gas and oil and between coal and oil;

- Reducing demand (or reducing the rate of growth of demand) for energy generally and for the oil share of total energy demand specifically.

Assuming a tight supply situation (but not actual shortages, where supply directly constrains consumption) a number of tools can be used to accomplish one or the other or both effects identified above. One, allowing oil products prices to rise, whether naturally or through additional taxes, can affect both substitutions and overall demand levels. For several reasons, oil prices may not be a completely adequate-short-to moderate term tool in all cases:

- The short-term substitution effects on oil are not completely price-related:
    - -- Gas substitution stems from curtailed gas supplies; price effects in this case depend on calling forth greater gas supplies with higher gas prices.
    - -- Coal-to-oil substitutions are difficult to reverse with prices; utilities, where the shift is most dramatic, can pass price increase through to consumers' level quickly -- due to fuel pricing clauses existing in current regulations.

  In both of these cases, the price effects may be long-run in nature.

- Reducing final demand through price increases presents a difficult policy dilemma:
    - -- Because short and long-run price elasticities of demand for many oil products are low, large price increases are required in order to trim demand substantially.
    - -- Large price increases bring with them adverse equity effects; also, if they are "natural" increases rather than tax increases, windfall profit problems arise.

Neither point, however, is meant to imply that price increases are effective or improper policy options. Rather, they may be inadequate by themselves.

In addition to price, several steps which can reduce short-term substitution effects include:

- In the case of utilities, directly curtailing shifts to oil (and possibly to gas) and mandating reconversions to coal combined with the application of stack gas cleaning technology (possibly aided by high financial penalties for non-compliance with environmental standards).
- As indicated previously, decontrol of field prices of natural gas (to stimulate supply) coupled with direct action (similar to utilities) to prevent the siphoning-off of gas supplies by large-scale consumers who could burn coal and economically treat stack gases.

In addition to price increases, a number of direct energy conservation actions potentially could trim final oil demand; however, their short-run effectiveness on a voluntary basis is unclear. Three problems stand in the way of direct enforcement of energy conservation measures in the short-to-moderate term:

- The major known devices which waste energy (autos and buildings) are long-lived; direct actions aimed at new autos and new building proceed no faster than the rate at which new devices "roll-in" to the inventory.
- Options to directly effect the existing stock of autos and buildings are lacking; consequently, short-run conservation depends on the unknown response of consumers to requests for voluntary demand reductions. In some other areas, such as reduced highway speeds, the large costs of enforcement tend to make direct steps largely resort to voluntary compliance.

These two observations are not meant to imply that direct energy conservation actions (e.g., regulation auto fuel economy, upgrading Federal insulation standards for housing and increasing their applicability across new construction) or voluntary requests are futile. Instead, they do imply that trimming demand in the short-run is uncertain and, unfortunately, their potential may increase rapidly in the case where a general shortage occurs.

6. OPTIONS FOR FACILITATING MAXIMUM PERFORMANCE OF THE EXISTING SUPPLY SYSTEM

During 1972, two principal factors related to government policies and activities created a degree of "stickiness" in the oil supply system:

- Price controls, under the Economic Stabilization Program, caused a refining bias toward gasoline (at the expense of distillate) and acted against sales of crude by industry majors.
- Oil import quotas contributed to the slow response of total crude supply in the face of declining domestic crude production.

The first of these two factors has been relieved partially by selected price increases allowed under the Phase IV stabilization program; price constraints, however, still may be creating an element of friction in oil supply. The second of these factors -- quota controls on both crude and products -- were relieved parially by abandonment of volumetric quotas at the outset of the second quarter of 1973. Two potential areas of stickiness, however, may remain in the new import control system·

- The combination of rising world crude prices and the low tariff initially established on crude imports have driven the value of quota tickets (which are fee exempt) to low levels; this fact, combined with generally tight crude supplies and an apparent move by the oil majors to shift profit realization downstream from crude production, may be acting against the free flow of crude from inland to independent refiners.
- The initial product tariff differentials provided under the new import program were created to encourage greater importation of heating fuels relative to gasoline; accelerating the 1975 date where the differentials are scheduled to disappear -- by reducing gasoline duties -- could increase product import supply options. The effect, however, will not be instantaneous because gasoline currently is difficult to purchase in world markets and because foreign gasoline is not uniformally U.S.-market compatible.

Resolving either of these remaining import program problems could create other problems. Specifically, the constrained flows of crude from majors to independents largely stems from the natural inclination of vertically integrated producers in a raw materials constrained industry to retain supplies rather than to meet the needs of producers lacking backward integration to the raw materials level.

Of course, at some level of raw material prices, integrated majors might be expected to sell crude to independents at the expense of their own wholesalers and retailers. Two things, however, mitigate against this. First, the high prices potentially required to draw crude from majors will erode the retail price advantage of independents, which has been their prior basis of competition. Consequently, at prices adequate to stimulate crude sales, independents have less desire to buy crude.

Secondly, the apparent recent trend by majors to shift profit realization downstream from crude production makes increases in market share at the retail level more valuable. Accordingly, the short-run economic advantages of crude sales to independents is offset, from the majors' point of view, by the long-run advantages of increasing their market shares at the expense of independents.

These phenomena are the bases for current proposals to require allocations of crude (and products) by majors to the independents which depended on them during the prior era of domestic oil surplus. Certainly, allocations can maintain independents and preserve an element of the particular variety of price competition at the retail level which the independents provided previously. As a temporary measure, assuming a return to surplus conditions in the moderate-term, this might be prudent policy. Short of a return to surplus, however, this course may fail to solve the fundamental problems of insuring an adequately competitive market in oil goods and may make permanent the government role of supporting a class of economic units which are basically weak due to a lack of access to raw materials. Facing this prospect, it would appear that a more fundamental change in industry structure -- after careful considerations of its costs versus its potential competitive benefits -- should be weighed.

The second problem related to imports -- the differential tariff structure -- largely exists to decrease incentives for exporting crude refining capacity in the future. For this reason, the current import program plans to raise fuel tariffs in 1975 to levels equal to gasoline (and, generally, to increase duties for crude and gasoline, simultaneously). If the opposite course is followed in the short-run -- reducing gasoline tariffs to current fuel tariff levels -- the incentive for domestic refinery construction induced by the tariff structure may need to be reinstituted by other means. In our opinion, it may be a preferable course of action to use import tariff flexibly to manage short to moderate term oil supply problems. And, rather than directing moderate-to-longer term refinery investment (and domestic crude capacity development) by a firm, fixed tariff schedule set now, application of direct controls on foreign investment and direct incentives for domestic investment may be preferable.

7. OPTIONS FOR DEALING WITH SHORTAGE CONTINGENCIES

Because foreign crude supply is unstable, is concentrated to a large extent in the Middle East (where consuming country economic leverage is minimal and political instability abounds), and is highly interconnected to traditional U.S. crude supply points (in Canada and in Caribbean areas other than Venezuela), short-to-moderate term U.S. oil supply has an element of catastrophic risk associated with it. For this reason, as well as the fact that the impact of any curtailment will develop rapidly in light of tight U.S. capacity and low stocks, contingency planning and implementing the rudiments of a contingency apparatus is important.

Any contingency plan should have several key features:

- It should attempt to prioritize fuel uses; limiting, first, the most marginal fuel uses and, last, those that are vital to economic and military security.
- Where use must be limited, it should attempt to level the amount of sacrifice regionally and across income groups.
- It should be notched, that is a portfolio of increasingly severe remedies should be available, each of which can be instituted as a function of the degree of shortage encountered.

Should mild shortage levels be encountered, the ingredients of a contingency plan probably can be simple; also, the needs for a standby institutional apparatus can be minimal. Experience during shortage periods in 1972 and 1973 suggests that, up to a point, the supply system can adjust reasonably equitably and in priority fashion and that demand responds well to shortage signals as they appear at the retail level (e.g., curtailment of gasoline service station hours). In addition, price can be used as a rationing tool without catastrophic income inequities.

At higher levels of shortage, however, the selection of appropriate tools becomes extremely complex, for several reasons:

- Given low price elasticities of demand, the rate of price increase may become extreme; both general price inflation, income inequities, and windfall profits become increasingly serious problems.

- On the other side of the price argument, failure to allow price adjustments in the face of shortage and the "penny nail" nature of petroleum in a myriad of final goods can cause general cost push inflation with attendant general economic problems and income inequities and windfalls in industries dependent on petroleum inputs. This can occur because the effective capacity of many industries can be constrained short of final demand by shortages in oil-related inputs. If demand is not constrained simultaneously by permitting price increases, cost push and demand pull inflation can accelerate.

- The potential for regional inequities increases -- since internal U.S. differences exist between regions in terms of oil-producers versus oil consumers.

These problems tend to suggest that direct controls -- rather than price -- are better tools in the face of more severe shortages. Unfortunately, they bring with them large problems, too:

- The general complexity of energy-related economic activity makes the avoidance of perverse secondary effects of control decisions nearly impossible to avoid.

- The political circumstances surrounding direct controls -- to maintain highly apparent personal conforts rather than only indirectly apparent economic activity -- work against proper prioritization of needs.

- Even within the personal comforts arena, natural pressure protecting heating fuels at the expense of gasoline exposes a large sector of the economy (auto-related use, which supports approximately 25 percent of U. S. GNP) to severe economic impact.

Finally, to adequately optimize the availability of alternate refinery products could require direct controls over refinery yields. Consequently, controls at the level of final demand -- which attempt to correctly prioritize competing claims on crude -- by operating at the consumer level, soon need to extend upstream through the petroleum processing industry. Of course, the control institutional apparatus required increases rapidly, and the internal problems of coordinating such an apparatus become immense.

In planning for contingencies, then, several guiding points are that:

- Price-based controls probably should be employed as a first remedy; in the face of increasing shortage, they should be stretched to the limits of their effectiveness and alternative measures should be employed to reduce adverse income equity and windfall profit effects.
- Direct controls probably should be reserved as a last resort and, then, be confined to as narrow a range of products as possible; they should add to price-based controls only where price-based controls become ineffective rather than supplant them.

8. OPTIONS INCREASING OUR ABILITY TO "MANAGE CLOSE TO THE EDGE"

As has been pointed out throughout our analysis, publically available information is inadequate to the task of managing well in an era of shortage. Several key areas of concern include:

- The lack of accurate final consumption data (as opposed to the current. imputed demand data).
- The untimeliness of current data, coupled with a high error rate in initial reporting.
- An absence of knowledge about import capabilities and, generally, detailed information on the world oil demand and supply structure and events.

In addition to these fundamental problems, there is a general lack of tools to signal the onset of shortage in any degree short of a catastrophic event such as curtailment of Middle East crude supplies. The problems with currently contemplated signal devices are as follows:

- Detailed supply flows data do not suffice because current ability to predict demand -- against which the adequacy of supply must be compared -- is weak.

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- Stocks can act as a leading indicator, but shed little light on degree of shortage; because of fixed supplier commitments and because suppliers will begin to reduce shipments to buyers who can be curtailed (due to their lack of contractual arrangements) well in advance of actual shortage, shortage incidents can occur while current stock levels appear flush.

- Measures based on spot prices or on shortage incidents are weak on three counts:

  -- Because of the stock phenomena, described above, the incidents caused numerous, small incidents even where actual shortages are small.

  -- Because many buyers who are curtailed attempt to buy quantities from every possible outlet, the apparent size of curtailed demand is magnified many fold in the marketplace; in response, spot prices soar to a "reflected" demand much larger than the real shortage amount.

In considering a contingency program, these problems must be solved in order to avoid an overdose of remedies, particularly considering the drawbacks of the control options. Principally, the critical areas for improvement are:

- Improved forecasting capability, coupled with more reliable and nearly "real-time" supply information.

- Much greater, hands-on data collection at the final consumption level.